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Self-supervised physics-based deep learning reconstruction without fully-sampled data

Methods for training machine learning algorithms without fully-sampled reference data for inverse problems.

IP Status: US Patent Issued; Issued US Patent No. 12,106,401

Applications

Medical image reconstruction - MRI, CT, etc

Overview

Several machine learning (ML) methods are being developed to improve regularized reconstruction in a multitude of inverse problems, especially in computational medical imaging (e.g. MRI, CT). Some of the most successful methods use a physics-based ML reconstruction approach, wherein the reconstruction is performed by "unrolling" an optimization algorithm into a neural network that alternates between a regularizer unit and a data-consistency unit. However, these networks are typically trained in a supervised manner, requiring a large database of fully-sampled (reference) data at the desired resolution, which is often impossible to acquire. On the other hand, training using lower-resolution reference data has not been effective in reconstructing higher-resolution data.

Researchers at the University of Minnesota have developed a novel approach for self-supervised training for physics-based ML reconstruction in inverse problems, without requiring a database of fully-sampled data. With this approach, algorithms can be trained on existing databases of undersampled images (e.g. as in the case of the Human Connectome Project) or on a scan-specific manner. This novel approach is highly effective in scenarios where acquiring fully-sampled datasets are not available or impossible due to organ motion or physical constraints such as signal decay. When implemented in MRI or CT systems for image reconstruction, the scan time can be significantly reduced while improving the quality of reconstructed images without having to modify acquisition hardware. The researchers have shown that the performance of this self-supervised learning method to be similar to that of supervised approaches that are trained with fully-sampled reference.

Key Benefits & Differentiators

- Unsupervised training when fully-sampled reference data is not available
- Compatible with standard conventional MRI or CT scanners with no changes to data acquisition
- Compatible with any neural network that a company may already use
- 4x better than standard techniques from a noise perspective, which can be exploited via acceleration or improved spatial resolution
- Can provide acceleration rates beyond what is specified by the number of coils

Phase of Development

TRL: 6-7

Demonstrated on 3T MRI brain data, MSK (knee) data, 1.5T cardiac data.

Technology ID

2020-125

Category

Engineering & Physical Sciences/MRI & Spectroscopy
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Publications

Self-supervised physics-based deep learning MRI reconstruction without fully-sampled data. 2020 IEEE 17th International Symposium on Biomedical Imaging (ISBI). IEEE, 2020. Best Paper Award

Self-supervised learning of physics-guided reconstruction neural networks without fully sampled reference data. Magn Reson Med, Volume 84, Issue 6, December 2020, pp. 3172-3191 doi: 10.1002/mrm.28378.

High-Fidelity Accelerated MRI Reconstruction by Scan-Specific Fine-Tuning of Physics-Based Neural Networks. 2020 IEEE 42nd Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), IEEE, 2020.

Desired Partnerships

This technology is now available for:

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- Sponsored research
- Co-development

Please contact us to share your business' needs and learn more.