3D Cardiac MRI Cine Image Denoising

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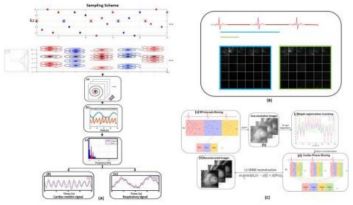
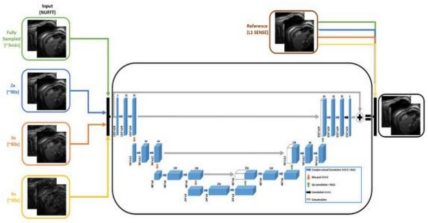
Background

- We developed a rapid 3D self-gated cardiac cine technique, using a variable-density undersampled randomized stack of spiral gradient echo sequence to perform cine evaluation of the whole left ventricle. Our proposed slice-by-slice deep learning-based imaging reconstruction technique for self-gated free-breathing 3D stack of spiral cardiac cine imaging can produce cine images with high temporal (40 ms) and spatial resolution (1.25x1.25x8 mm) within a 20s acquisition time with <1s deep learning inference time.



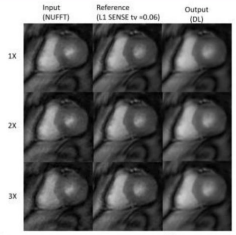
Methods

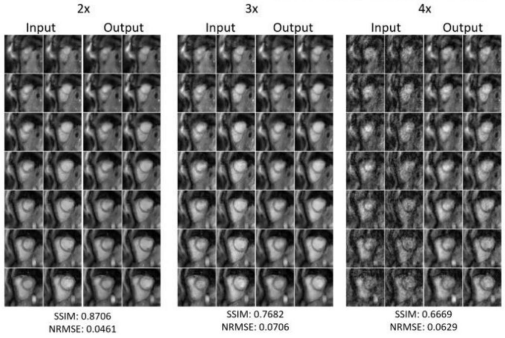
The proposed 3D DESIRE U-Net image reconstruction framework[1]. Following binning and motion correction, the 3D SPARCS data is reconstructed using a 3D gpuNUFFT followed by optimal coil selection and combination. The training dataset has 144 slices of 3D SPARCS images from 20 cases, and the validation data has 17 slices of 3D SPARCS images from 2 cases. Different under-sampled rate input images are reconstructed by retrospective down sampling from the fully samples data and using 3D gpuNUFFT with the reference of fully sampled L1 SENSE images. The training of networks (D3K32) was conducted on a single GPU (RTX4090, Nvidia).



Results

DL reconstruction cine images for different retrospective under sampled rates compared with reference images. 60s acquisition gives the best tradeoff between image quality and acquisition time.





DL reconstruction end systole and end diastole images for different retrospective under sampled rates compared with reference images..

Conclusions & Future Work

Our proposed deep learning-based imaging reconstruction technique for self-gated free-breathing 3D stack of spiral cardiac cine imaging can produce cine images with high temporal and spatial resolution with a 60s acquisition with a deep-learning inference time of <1s.

We need to further fine tune the network to improve the image quality.

Reference

1. Wang J, Weller DS, Kramer CM, Salerno M. DEep learning-based rapid Spiral Image REconstruction (DESIRE) for high-resolution spiral first-pass myocardial perfusion imaging. NMR Biomed. 2022;35:e4661.
2. Knoll F, Schwarzl A, Diwoky C, Sodickson DK. gpuNUFFT – An Open Source GPU Library for 3D Regridding with Direct Matlab Interface Proc Intl Soc Magn Reson Med. 22 (2014). p 4297

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