Deep Learning Reconstruction for Cardiac Magnetic Resonance Fingerprinting

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Category

Medical Devices

Life Sciences

OVERVIEW

Image reconstruction pipeline to display cardiac MRF maps in DICOM format at the scanner in 40 seconds

- Pulse sequences for spiral trajectory measurement and cardiac MRF T1, T2, and M0 mapping (native and post-contrast)
- Image reconstruction software for cardiac MRF, including low-rank and Deep Image Prior methods
- Software for calculation of synthetic multi-contrast LGE images

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BACKGROUND

Quantitative MRI is a powerful tool for assessing cardiac health. Two clinically measured tissue properties are T1 and T2, which can be used for early detection and monitoring of fibrosis, inflammation, and edema, among other conditions. Cardiac magnetic resonance fingerprinting (cMRF) is one technique for simultaneous T1-T2 mapping, which uses a time-varying sequence, an undersampled spiral k-space trajectory, and pattern matching with a dictionary of simulated signals to estimate quantitative maps.

Although the cMRF acquisition is efficient, with data collected during one breathhold, the reconstruction time is long and prohibits real-time display of the maps. One major hurdle is that the subject's cardiac rhythm determines the pulse sequence timings because the scan is electrocardiogram (ECG) triggered. As a result, a new dictionary must be simulated after every acquisition that appropriately models the scan timings to obtain accurate quantitative maps. A typical cMRF reconstruction uses a dictionary with over 20,000 T1-T2 entries and requires 5 minutes to calculate from a Bloch equation simulation (including corrections for slice profile and preparation pulse efficiency).

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INNOVATION

In this work, University of Michigan researchers have developed an efficient cardiac MRF reconstruction pipeline for simultaneous T1, T2, and M0 mapping. The package provides:

- Spiral trajectory measurement and cardiac MRF pulse sequence files for Siemens XA scanner versions
- MATLAB code for processing cardiac MRF maps (both pre-contrast and post-contrast) using a low-rank reconstruction. Recommended MATLAB version 2023a or later on Windows or Linux.
- MATLAB code for calculating synthetic multi-contrast LGE images from post-contrast MRF T1 and T2 maps.
- Python code for reconstructing MRF T1, T2, and M0 maps with reduced noise and higher precision using a Deep Image Prior. Recommended running on Linux with a GPU.

Questions or Additional Information: Please contact Jesse Hamilton (hamiljes@med.umich.edu) or Nicole Seiberlich (nse@med.umich.edu).

ADDITIONAL DETAILS

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