

Proceedings Article

# Real FFL-based MPI dataset for multi-task learning

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## Abstract

Deep learning, owing to its potent nonlinear fitting capacity, has been increasingly applied to magnetic particle imaging (MPI)-related tasks to enhance the system performance. Nevertheless, the efficacy of deep learning models is contingent upon the availability of extensive training data. Currently, the availability of real-world datasets suitable for deep learning training and testing remains limited, thereby compromising the generalizability and practical efficacy of data-driven approaches in real-world deployment scenarios. To mitigate this limitation, the proposed MPI-image dataset supports multiple image-centric tasks including anisotropy analysis and denoising, thereby facilitating the development and validation of deep learning approaches under real-world conditions.

## I. Introduction

Magnetic particle imaging (MPI) is a tracer-based tomography technique that detects the concentration distribution of superparamagnetic iron oxide nanoparticles (SPIONs) [1]. To enhance the performance of MPI systems and obtain higher-quality images, deep learning methods have been extensively adopted for tasks such as image reconstruction [2], denoising [3] and deblurring [4].

However, the real-world MPI images are scarce, most deep learning models are trained on datas such as MNIST [5], tumor phantoms [6], or vascular phantoms [7] using for the simulation. This practice reduces the ability of the model to generalize in real-world scans. The best-known real-world dataset is the OpenMPIData dataset [8]. However, the dataset is small and provides raw measurement and calibration data, which can be used in only system matrix-based reconstructions.

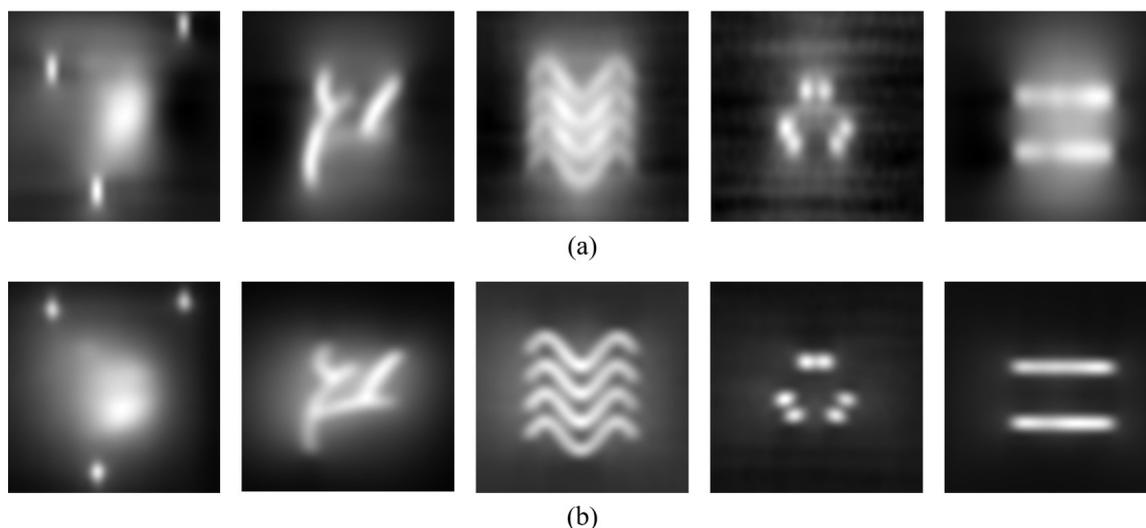
To fill the gap in real-world MPI data reconstructed by X-space method, we built an FFL-based real-world dataset. It supports anisotropy correction, resolution enhancement, denoising, and other tasks.

## II. Methods and materials

The main steps of dataset construction are as follow.

First, binary patterns of phantoms such as shapes, vessels, and tumors are designed. Next, the phantoms are 3-D printed to 3 cm × 3 cm × 1 cm. Finally, the commercial MPI scanner (MOMENTUM, Magnetic Insight, Alameda, CA, USA) [9] acquires the images that form the dataset.

Each phantom is scanned twice on the same commercial MPI scanner. The first scanning mode is default mode (Gradient: 5.7 T m<sup>-1</sup>, Field of View (FOV): 12 cm × 12 cm). In the default mode, only the z-direction channel is adopted for image reconstruction. The second is



**Figure 1:** The samples of real-world images. (a) The image collected through the default mode. (b) The image collected through the isotropic mode.

isotropic mode (Gradient:  $5.7 \text{ T m}^{-1}$ , FOV:  $12 \text{ cm} \times 12 \text{ cm}$ ). The isotropic mode integrates both the x-direction and z-direction channels for image reconstruction. The two images can be used as a pair or separately, depending on the task. The tracer is Perimag (10 mg Fe/mL). Finally, a total of 162 images were used as the whole dataset.

### III. Results and discussion

Sample images from the built dataset are shown in Figure 1. The first row presents images acquired in default mode, while the second row shows those from isotropic mode. It can be observed that images from isotropic mode exhibit higher resolution and lower noise levels.

### IV. Conclusion

We built an FFL-based MPI dataset for multi-task learning. The images support real-world MPI tasks such as denoising and resolution improvement. We will keep enlarging the dataset and add more biological patterns.

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### Author's statement

Conflict of interest: Authors state no conflict of interest.

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