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Physics-Informed Deep Neural Nets for Super-Resolution, Denoising, and Velocity-Aliasing Correction of 4D-Flow MRI ROSHAN D'SOUZA, University of Wisconsin-Milwaukee, MOJTABA FATHI, ISAAC PEREZ-RAYA, University of Wisconsin - Milwaukee — 4D-Flow MRI is a non-invasive method for measuring blood velocities in the human vascular system. It suffers from issues such as low spatio-temporal resolution, acquisition noise, and velocity-aliasing artifacts. Here, we present a novel method based on physics-informed Deep Neural Nets (DNNs) for super-resolution, denoising, and velocity-aliasing correction of 4D-Flow MRI. The inputs are the sparsely-sampled 4D-Flow MRI images and a rough geometry mask. The loss function used to train the physics-informed DNN contains terms for volume-averaged data fidelity and point-wise flow physics. Noise is reduced by using an averaging filter on the input data as well as the DNN predictor. Velocity aliasing is handled by computing data fidelity in the velocity encoding space. The trained DNN can be sampled at any desired resolution to generate noise-free flow images without velocity aliasing. Preliminary tests on CFD-derived 2D synthetic data shows that the method is able to automatically address all the aforementioned issues with normalized-root-mean-squared-error in velocity less than 4.8 percent and direction error less than 0.096 when compared to the reference CFD.

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