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Regularized Inverse Holographic Volume Reconstruction for 3D flow diagnostics[1] JIARONG HONG, MALLERY KEVIN, University of Minnesota — We introduce regularized inverse holographic volume reconstruction (RIHVR) for 3D flow diagnostics using a single camera digital inline holographic particle tracking velocimetry (DIH-PTV). RIHVR solves an inverse problem whereby the 3D optical field best matching the recorded hologram is iteratively reconstructed utilizing the sparsity and spatial smoothness of the volume to regularize the solution. The reconstruction in RIHVR is substantially noise-free with improved axial resolution and increased maximum tracer concentration relative to prior DIH-PTV methods. The use of sparsity regularization in RIHVR enables a sparse data representation which reduces memory requirements and allows processing very large holographic images while simplifying the identification and tracking of individual particles. Using synthetic data, RIHVR shows a 40% improvement in localization accuracy and a 4x reduction in the RMS velocity fluctuation in addition to a threefold increase in the allowable tracer concentration. RIHVR further demonstrates its capability through measurements of microfiber dynamics with nanometer resolution in all three directions, swimming tracks of algae in a dense suspension, and the rotation rate of non-spherical particles in a T-junction flow.

Jiarong Hong
University of Minnesota

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