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Machine learning method for 3D particle tracking velocimetry based on digital inline holography[1] JIARONG HONG, RUICHEN HE, SIYAO SHAO, KEVIN MALLERY, SANTOSH KUMAR, University of Minnesota — We present our recent work incorporating machine learning into the reconstruction and tracking processes of 3D particle tracking velocimetry based on digital inline holography (ML-DIH). Specifically, we developed a U-net based convolutional neuron network (CNN) architecture for hologram reconstruction and long short-term memory (LSTM) recurrent architecture for 3D particle tracking. The performance of our machine learning approach has been evaluated through 3D flow measurements in four cases, i.e., synthetic isotropic turbulence, droplet characterization in sprays, microorganism locomotion, nanoparticle deposition on surfaces. Through these measurements, our ML-DIH has demonstrated its ability: (i) to achieve high precision PTV at a tracer concentration more than 10 times higher than conventional DIH methods (in the synthetic turbulence case); (ii) to obtain accurate characterization of particle size and shape across more than two orders of magnitude in scale (in the spray case); (iii) to reconstruct complex locomotion trajectories over dense cellular medium (3×10^6 cells/ml) (in the microorganism locomotion case); and (iv) to capture nanoparticle motions at nanoscale precision in highly nosy images (in the nanoparticle deposition case).

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