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Paper Review: Super-resolution reconstruction of turbulent flows with machine learning

Xiaowei Jin

We use machine learning to perform super-resolution analysis of grossly under-resolved turbulent flow field data to reconstruct the high-resolution flow field. Two machine learning models are developed, namely, the convolutional neural network (CNN) and the hybriddownsampled skip-connection/multi-scale (DSC/MS) models. These machine learning models are applied to a two-dimensional cylinder wake as a preliminary test and show remarkable ability to reconstruct laminar flow from low-resolution flow field data. We further assess the performance of these models for two-dimensional homogeneous turbulence. The CNN and DSC/MS models are found to reconstruct turbulent flows from extremely coarse flow field images with remarkable accuracy. For the turbulent flow problem, the machine-leaning-based super-resolution analysis can greatly enhance the spatial resolution with as little as 50 training snapshot data, holding great potential to reveal subgrid-scale physics of complex turbulent flows. With the growing availability of flow field data from high-fidelity simulations and experiments, the present approach motivates the development of effective super-resolution models for a variety of fluid flows.

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