Super-resolution reconstruction of turbulence through unsupervised deep learning

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Turbulent flow is chaotic, nonlinear, and multi-scale. Therefore, high temporal and spatial resolutions are required to accurately represent turbulent flow. With an increase in data through experimental/computational researches, a super-resolution reconstruction of turbulence through supervised deep learning has been conducted. The supervised learning model needs labeled low- and high-resolution data, but there are only a few labeled data in turbulent flows. In this study, we investigate the applicability of an unsupervised deep learning model, based on generative adversarial networks (GAN), using unlabeled data for super-resolution reconstruction of turbulence. We adopt a representative example using unpaired large-eddy simulation (LES) and direct numerical simulation (DNS) data in turbulent channel flow. In this example, a supervised learning is impossible. As a result, our unsupervised learning model shows excellent performance. The reconstructed flow field from LES data is similar to DNS flow field in terms of statistics. We demonstrate that unsupervised learning is capable of super-resolution reconstruction of turbulent flows.

Acknowledgments This work was supported by a National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIP) (2017R1E1A1A03070282).

References

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