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Turbulent Channel Flow Synthesis using Generative Adversarial Networks

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Abstract : In fluid dynamics, direct numerical simulations (DNS) of turbulent flows require large amounts of nodes to appropriately resolve all scales of energy transfer. Due to the size of these databases, sharing these datasets amongst the academic community is a challenge. Recent work has been done to investigate the use of super-resolution to enable database sharing, where a low-resolution flow field is super-resolved to high resolutions using a neural network. Recently, Generative Adversarial Networks (GAN) have grown in popularity with impressive results in the generation of faces, landscapes, and more. This work investigates the generation of unique high-resolution channel flow velocity fields from a low-dimensional latent space using a GAN. The training objective of the GAN is to generate samples in which the distribution of the generated samplesis ideally indistinguishable from the distribution of the training data. In this study, the network is trained using samples drawn from a statistically stationary channel flow at a Reynolds number of 560. Results show that the turbulent statistics and energy spectra of the generated flow fields are within reasonable agreement with those of the DNS data, demonstrating that GANscan produce the intricate multi-scale phenomena of turbulence.

Keywords : computational fluid dynamics, channel flow, turbulence, generative adversarial network
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