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**LES Turbulence Model with Learnt Closure; Integration of DNN into a CFD Solver** MAJID HAGHSHENAS, PEETAK MITRA, University of Massachusetts Amherst, NICCOLO DAL SANTO , MathWorks, MATEUS DIAS RIBEIRO , German Research Center for Artificial Intelligence (DFKI), SHOUNAK MITRA, MathWorks, DAVID SCHMIDT, University of Massachusetts Amherst
— Turbulence modeling has been an ongoing subject of study. While high-fidelity turbulence models such as Large Eddy Simulation (LES) show promise, there is a continuing need for better closure models for subgrid flow features. Here we propose a CFD-DNN approach to use a data-driven closure for approximations of subgrid features and close an LES model. The workflow is implemented in an open-source CFD solver (OpenFOAM), and learning is performed using MATLAB. Our approach proposes the use of neural networks to estimate the closure model relating the small scales to the mean flow features. A high-fidelity LES method with a well-established closure model is utilized to generate ground truth data, which is used to train the ML model. The trained model is integrated with the CFD solver to predict eddy viscosity. The CFD-DNN solver is tested for a standard channel-flow problem and also on a practical Internal Combustion Engine (ICE) simulation, which involves complex flow features. Additionally, different network architectures and the corresponding accuracy and efficiency are reported. Overall, the approach shows promising results and provides new opportunities for developing CFD-ML infrastructure.

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