

Estimation of Turbulent Flow from Wall Information via Machine Learning

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Abstract: Along with rapid development of computer technologies, a wide range of turbulent flows have been investigated by direct numerical simulations and the big databases have been built throughout the world. From the DNS results, we can investigate turbulent characteristics in three-dimensional space and time. In the laboratory experiment, we can apply sophisticated laser diagnostics technique to measure flow field non-invasively in research. On actual equipment, it is very difficult to get the flow field data away from the wall. We can measure only wall information, such as wall shear stresses and pressure. When we predict turbulence from wall information, we can improve performance of thermal-fluid equipment and control turbulence better. In recent years, machine learning has achieved remarkable success in various research and developments fields. In this study, we apply a machine learning approach to wall turbulence in order to predict the flow field only from wall information. Direct numerical simulations of turbulent channel flow have been conducted to make training, validation and test datasets. We use pressure and shear stresses on a wall as input data since they can be measured by wall sensors in order to predict the flow field away from the wall with machine learning. Finally, we evaluate the usability of pressure and shear stresses on wall to predict the flow field.

Keywords: Wall Turbulence; Machine Learning; Direct Numerical Simulation



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