TOWARD OPTIMAL LES ON UNSTRUCTURED GRIDS

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Langford and Moser [2] introduced the concept of an "ideal LES" which is the best possible LES given that filtering incurs a loss of information. The ideal LES, based on the conditional average, can be proved to yield accurate large-scale one-time statistics and to minimize the error of large-scale short-time dynamics. However, the conditional average defining the ideal LES is impractical to compute because the condition is on the entire LES field. To reduce the computational cost to a practical level, the conditional average is approximated using stochastic estimation, resulting in an approximation to the ideal LES called "optimal LES".

The optimal-LES technique was applied to forced isotropic turbulence at $\mathrm{Re}_\lambda = 164$ by Langford and Moser [2] and to turbulent channel flow at $\mathrm{Re}_\tau = 587$ by Völker [3]. In these computations, the correlations required by the stochastic-estimation procedure were determined from Direct Numerical Simulation (DNS) data. This places an undesirable restriction on optimal LES because DNS data is available only at relatively low Reynolds numbers and for simple geometries.

The goal of the present work is to extend the applicability of optimal LES to high-Reynolds number flows and to complex geometries. To achieve this goal, we propose a new approach in which the correlations required by the stochastic-estimation procedure are computed from turbulence theory. More specifically, by using results from Kolmogorov's theory for isotropic turbulence, the new approach leads to stencil coefficients in terms of integrated multi-point correlations. The explicit dependence of the optimal-LES method on DNS data is thus eliminated, and its applicability is extended to high Reynolds-number flows in complex geometries.

Haselbacher et al. [1] carried out a preliminary verification of the new optimal-LES method for decaying isotropic turbulence on unstructured hexahedral grids. Good results were obtained for decay rates. The presentation will present these results as well as more recent studies which analyze the performance of the new optimal LES method in more detail.

References

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[3] S. Völker, "Optimal Large-Eddy Simulation of Turbulent Channel Flow," *Ph.D. Thesis*, University of Illinois at Urbana-Champaign, 2000.