

THE COMBINED EFFECT OF MESH ANISOTROPIES AND SCHEME'S ORDER ACCURACY ON THE PERIODIC HILLS CASE

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ABSTRACT

Within an academic environment, the periodic hills [1] case has been used as a simplified model to reproduce cases with a non-geometric flow detachment point and reattachment present in real-world phenomena. Its geometrical simplification has enabled the use of very smooth meshes that transition from the wall, where a finer mesh is required along the normal direction, to the furthest regions, which do not have as strict mesh requirements when LES or RANS models are used.

Nonetheless, there is a critical distinction between the meshes used in the academy and those used in industry daily: their "beauty". How meshes used in academic cases can show smooth transitions while preserving all geometric details. Or how meshes used in the industry require more aggressive stretchings to reduce the overall computational cost for an otherwise excessively costly simulation.

In this work, we aim to analyze the combined effect of the anisotropies present in real-world-like meshes, along with the formal order of accuracy of the used scheme. To achieve our goal, we have divided this study into two main blocks. In the first, the periodic hills test case will be studied on a set of refined meshes with smooth transitions using LES models and two different in-house numerical codes with different orders of accuracy: NOISEtte [2, 3], a high-order EBR, and TFA, a low-order numerical code in which calculations are performed using the HPC² framework [4]. In the second part, we will use another set of refining meshes with distorted regions and increased stretching factors to mimic what a mesh used in more industrial work would look like. This will help us to assess the differences between low- and high-accuracy schemes when applied to a set of smooth-transitioning meshes and to understand how these differences change as meshes begin to lose their uniformity.

REFERENCES

- [1] M. Breuer, N. Peller, C. Rapp, and M. Manhart, "Flow over periodic hills—numerical and experimental study in a wide range of reynolds numbers," *Computers & Fluids*, vol. 38, no. 2, pp. 433–457, 2009.
- [2] A. Gorobets, "Parallel algorithm of the NOISEtte code for CFD and CAA simulations," *Lobachevskii Journal of Mathematics*, vol. 39, pp. 524–532, may 2018.
- [3] A. Gorobets and P. Bakhvalov, "Heterogeneous CPU+GPU parallelization for high-accuracy scale-resolving simulations of compressible turbulent flows on hybrid supercomputers," *Computer Physics Communications*, vol. 271, p. 108231, feb 2022.
- [4] X. Álvarez, A. Gorobets, F. X. Trias, R. Borrell, and G. Oyarzun, "Hpc2—a fully-portable, algebra-based framework for heterogeneous computing. application to cfd," *Computers & Fluids*, vol. 173, pp. 285–292, 2018.