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PARALLEL SCHUR-FOURIER DECOMPOSITION FOR THE EFFICIENT SOLUTION OF POISSON EQUATION ON MASSIVE EXTRUDED UNSTRUCTURED MESHES

Ricard Borrell[1,2] , Oriol Lehmkuhl[1,2], Manel Soria [1] and Guillem Colomer[2]

[1] Centre Tecnològic de Transferència de Calor (CTTC)
Universitat Politècnica de Catalunya (UPC)
ETSEIAT, C. Colom 11, 08222 Terrassa (Barcelona), Spain
cttc@cttc.upc.edu, http://www.cttc.upc.edu

[2] Termofluids, S. L.
Magi Colet 8,
08204 Sabadell (Catalonia, Spain)

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ABSTRACT

A parallel Schur-Fourier Decompositon algorithm [1, 2] for the solution of discrete Poisson equation on extruded unstructured meshes is here proposed.

This method has been used to solve discrete Poisson equation on *Cartesian* grids [1, 2, 3]. Several time-accurate direct numerical simulation (DNS) and large-eddy simulation (LES) of wall-bounded incompressible turbulent flows were performed in different parallel systems using this approach [1, 2, 3]. The goal of the present work is to extend these algorithms to unstructured meshes.

The generalization to unstructured meshes allows to carry out simulations in complex geometries which are very difficult to discretize using cartesian grids. The unstructured meshes also provide more flexibility and efficiency of mesh concentration.

In the case considered, periodicity is assumed in the extrusion direction. Periodic boundary conditions are usually of interest for many LES and DNS applications. As there are no boundary layers on the periodic direction, mesh can have a uniform step in this direction and this allows to apply Fourier decomposition method.

The Fourier diagonalization uncouples the domain in the periodic direction and decomposes original 3D problem into a set of independent 2D problems, which will be called planes. This reduces dramatically the RAM memory requirements and the arithmetical complexity of the algorithm.

The parallelization is done on two-levels. First by partitioning the set of planes [3], second using parallel Schur decomposition method to obtain solution for each plane [4, 5] (See Fig. 1).

Performance tests will be carried out to illustrate the robustness and scalability of the method on different parallel systems. As a demonstrative applications of the algorithm LES time-accurate simulations of incompressible turbulent flows with complex geometries will be presented.

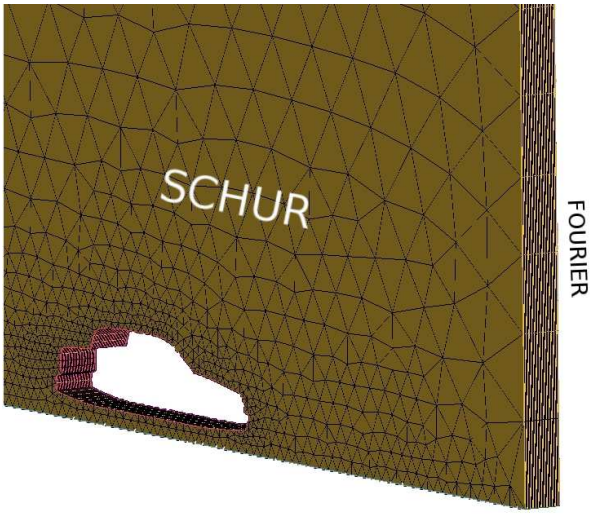

Figure 1: *Discretized domain using an unstructured mesh. Once FFT decomposition is applied a Schur Decomposition is performed to solve each plane.*

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