PARALLEL CFD SIMULATIONS USING EXPLICIT VERTEX-CENTERED METHODS FOR TETRAHEDRAL GRIDS

Ilya Abalakin, Andrey Gorobets, Tatiana Kozubskaya, Sergey Soukov

Institute for Mathematical Modelling RAS
ssoukov@gmail.com

Key words: *unstructured tetrahedral grids, vertex-centered methods, parallel CFD*

The paper presents a way of treatment of large tetrahedral grids, to provide parallel CFD simulations. The grid processing is needed due to a specificity of numerical algorithms in use and a necessity of parallel implementation, visualization and data treatment in cases of wide-meshed engineering problems.

The finite volume approach for the construction of vertex-centered algorithms (for example, [1], [2]) requires a preliminary definition of 3D control volumes (or cells), to approximate the conservation laws. The paper considers the building of such cells and investigation of their quality which strongly influences an accuracy of the numerical method in use. Figure 1 represents examples of 3D cells of two types: median cells and circumcenter cells.

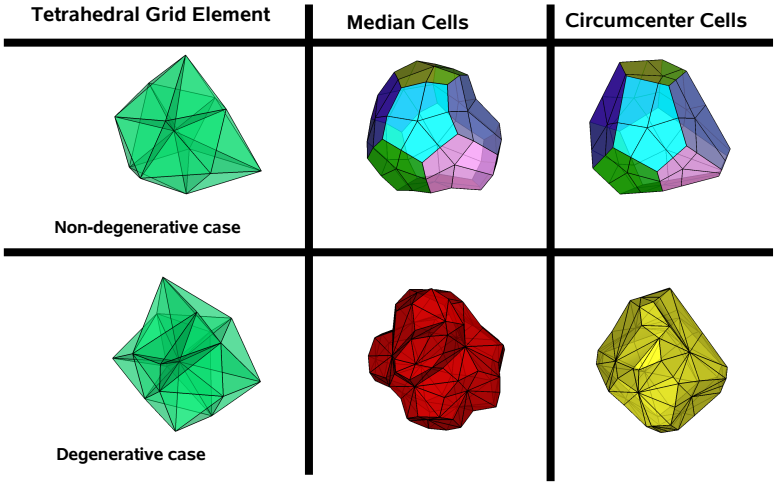

Fig. 1: Examples of 3D median and circumcenter cells

A special attention is paid to the construction of tetrahedral grid and cells in the boundary layer regions. An idea is to generate the grid in such a manner that the corresponding cells appear close to hexahedrons (or even to parallelepipeds). Figure 2 shows the patterns of the boundary layer grid treatment. The technique is based on the usage of structured boundary layer grids along the surface followed by specially oriented decomposition of cubes into tetrahedrons.

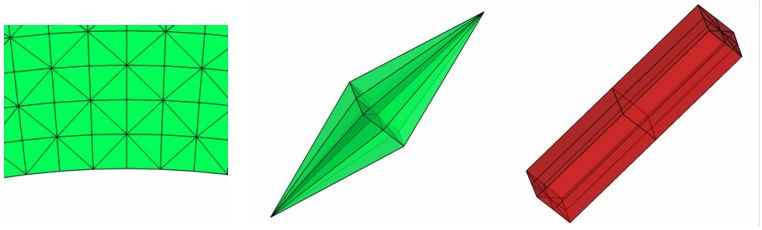

Fig. 2: Patterns of grid elements and cells in the boundary layer region

The paper is also devoted to a special grid and data treatment needed in case of very large meshes and usage of supercomputers.

The paper shows examples of parallel simulation of CFD and computational aeroacoustics (CAA) problems. The CFD problems under consideration concern with the external flow around of bodies (from a sphere to a vehicle). The CAA problem is represented by the simulation of acoustic energy loss in a resonator installed in the impedance tube. The problem is connected with the investigation of resonance-type sound-absorbing panels (acoustic liners) [3].

REFERENCES

[1] C. Debiez, and A. Dervieux, “Mixed element volume MUSCL methods with weak viscosity for steady and unsteady flow calculation”, *Computer and Fluids*, 29, 89-118 (1999)

[2] Ilya Abalakin, Alain Dervieux, and Tatiana Kozubskaya, “High Accuracy Finite Volume Method for Solving Nonlinear Aeroacoustics Problems on Unstructured Meshes”, *Chinese Journal of Aeronautics*, 19(2) (2006)

[3] Tatiana Kozubskaya, Ilya Abalakin, Andrey Gorobets, and Alexey Mironov, “Simulation of Acoustic Fields in Resonator-Type Problems Using Unstructured Meshes”, *AIAA-paper 2519-2006*