INVESTIGATION OF HIGH –ORDER RESIDUAL DISTRIBUTION SCHEMES FOR EXTERNAL AERODYNAMICS APPLICATIONS

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The von Karman Institute has been recently involved in the ADIGMA European project, whose objective is to investigate high-order CFD numerical schemes and understand their impact on future aircrafts design. To achieve this objective, each research institute involved in the project has been asked to use its own state-of-the-art CFD techniques (Residual Distribution Schemes in our case) to solve a series of test cases.

Within my personal project, part of these ADIGMA test cases have been simulated and analyzed in detail. We used them as "test bench" to understand strengths and drawbacks of (RDS) and find suitable improvements, both for numerical schemes and computational efficiency of the solver COOLfluiD. Concerning the schemes, we proposed two improvements of the shock-detector parameter appearing in the blended BX-scheme. In particular, we designed a shock-detector parameter more specialized to detect exclusively shocks. Concerning the solver, we firstly implemented the Cuthill-McKee algorithm to renumber the nodes of the grid and accelerate the computation. Subsequently, we tested different quadrature rules to compute the cell residual, in order to find an optimal compromise between accuracy and efficiency.

Finally, we implemented the first high-order 3D element (10-nodes Tetrahedron) in COOLfluiD. This task is still under development and represents a particularly important extension of the solving capabilities of COOLfluiD. We started to test the algorithm in a series of simple cases, implementing also the boundary conditions necessary for external aerodynamics simulations (Slip-Wall and Far-Field). Finally, we implemented the computation of aerodynamic coefficients for 3D high-order simulations. Future goal is, in fact, to use this 3D high-order element in the next ADIGMA simulations.

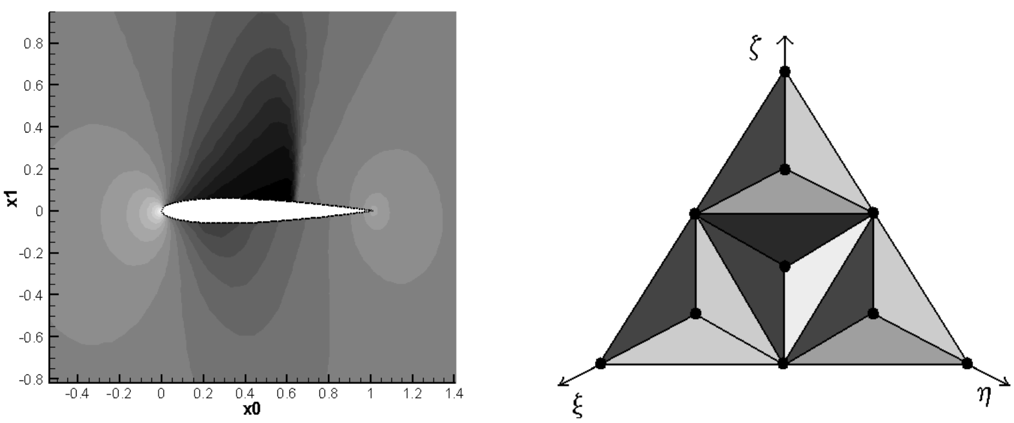

Figure 1: High order schemes and high order elements