HIGH PERFORMANCE OBJECT ORIENTED FRAMEWORK FOR SCIENTIFIC SIMULATION

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The goal of the thesis is to develop a framework for scientific simulation, which can be used in a wide range of applications as diverse as aerothermodynamics and aeroelasticity. In the last 6 years the framework has been developed by VKI and its partners at KULeuven, under the name **COOLF**lui**D** project, **C**omputational **O**bject **O**riented **L**ibrary for **Flui**d **D**ynamics.

It provides a suite of libraries for numeric simulation of multi-physics, on unstructured meshes, solved by multiple methods, and it aims at being the common framework for numerical work in the institute. During the last years several improvements were accomplished and the code has reached a status were it is used by other students as a platform for parallel scientific simulations for their PhD numerical work, and by DC students for the development of their thesis projects, hopefully minimizing their programming efforts.

The current version has many discretization methods, each useful for its own subset of CFD applications. The methods are Finite Volume and Residual Distribution both for compressible and incompressible flows, Finite Element and Spectral Finite Volume. Discontinuous Galerkin methods are currently being developed by in strong collaboration with a group from the Charles University of Prague.

These methods are used to solve problems with many different types of physics, like Euler and Navier-Stokes equations, ideal magneto-hydrodynamics for space weather forecast, high-energy flows at thermal equilibrium or chemical and thermal non-equilibrium, heat transfer and structural mechanics. A flexible data structure permits the solving of problems on hybrid unstructured meshes, of high-order elements, both 2D and 3D.

Recent efforts have been focused on developing high-order discretization schemes, i.e. higher than 2^{nd} order, for aerodynamic and aeroacoustics applications. These efforts were on the frame of the EU project ADIGMA and the SBO project Capricorn.

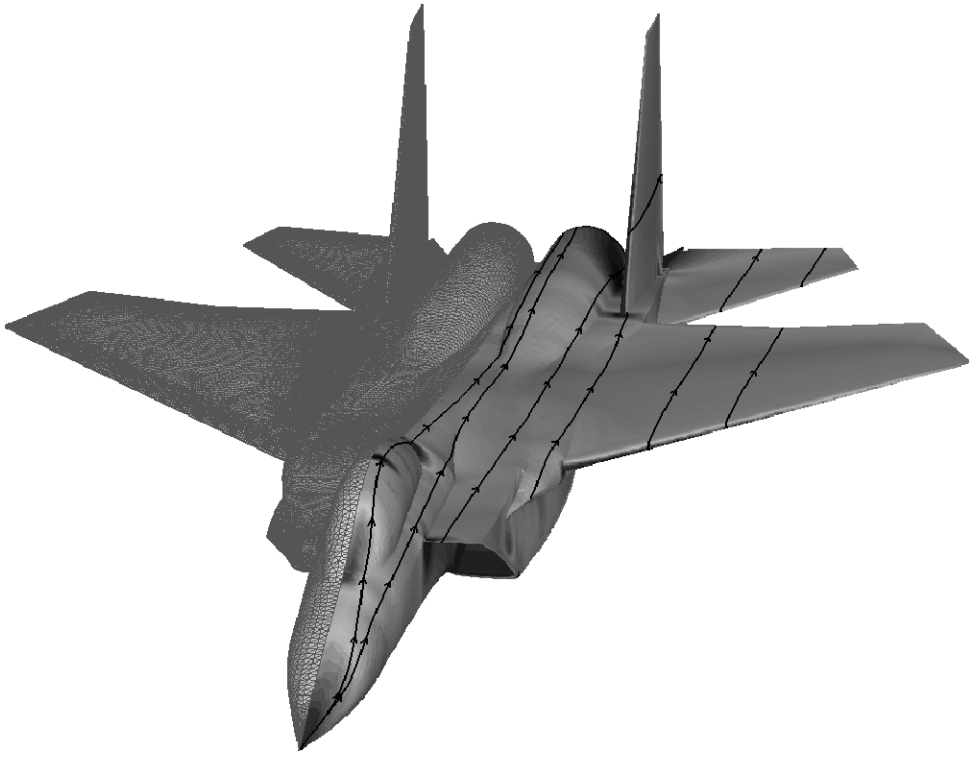

Figure 1: Transonic flow over F15 fighter jet. Residual Distribution method, P1 B-scheme