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Editorial

Preface to the special issue "High order methods for CFD problems"

Since a few years, there has been a renew in interest in (very) high order schemes for compressible fluid dynamics for steady and unsteady problems. Within Europe and the US, several conferences deal with these issues, some of them have been launched only recently. Several special issues of recent or future AIAA conferences are specially devoted to that topic. The goal of these researches is to design cheaper and more efficient numerical methods able to handle very large and very complex problems.

When dealing with complex geometries, such as part or full aircraft, several difficult issues have to be addressed:

1. Accuracy and robustness: the same method has to be able to deal with smooth and non smooth flows. Since the geometry is in general complex, unstructured meshes are most often used, so that one has to understand in detail how to use non linear filtering methods, such as limiters, to remove spurious oscillations without spoiling the accuracy in smooth regimes.
2. Mesh generation: one of the key issue is to generate meshes where the geometry is accurately represented, and the numerical method able to handle this easily,
3. The volume of computation: the number of degrees of freedom increase very quickly, so that it becomes uneasy to visualize them. More over, it is not clear whether or not current visualization tool are adapted to data structure generated by high order schemes, probably not.
4. In order to lower the number of degree of freedom and to make computations simply doable, tools are mesh adaptation, in particular goal oriented mesh adaptation.

This interest has reached the industry community rising new problems to the academic community. For example, the specific target research project "Adaptive higher-order variational methods for aerospace applications" (ADIGMA) was initiated within the 3rd Call of the 6th European Research Framework Programme (2006–2009) [10] has gathered academic teams from Europe and one from China,[1] Research institutes[2] and industrial partners[3] The papers contained in this special issue are mostly coming from ADIGMA partners, but not only since we have tried to open the community and the range of methods.

More specially, the following items are covered:

1. Approximation. The approximation of the Euler and Navier–Stokes equations is covered by [13,1,5] using residual distribution schemes, and [7,4,12,16] with Discontinuous Galerkin methods. Other kind of high order approximation are also covered such as high order finite differences [6], iso-geometric analysis [2], and artificial viscosity methods [8] or low dissipative methods [14].
2. Efficiency in the solvers in [15,3].
3. Some adaptation strategies [9], other can be found (with second order methods) in [11].

The development of efficient and reliable very high order scheme is still an ongoing work, according to the abundant literature and workshops, see for example the 1st International Workshop on High-Order CFD Methods http://www.public.iastate.edu/zjw/hiocfd.html.

[1] The complete list is the University degli Studi di Bergamo (Italy), Ecole Nationale Supérieure des Arts et Métiers (Paris, France), the University of Nottingham (UK), Charles University (Prague, Czech Republic), the University of Wales (Swansee, UK), The University of Stuttgard (Germany), Uppsala University (Sweden), the University of Twente (The Nerderlands), Warsaw University of Technology (Poland), Najing University (PR China).

[2] ARA (UK), DLR (Germany), ONERA (France), INRIA (France), VKI (Belgium).

[3] Alenia Aeronautica (Italy), Airbus (France and Germany), Dassault Aviation (France), EADS-MAS (Germany) and CENAERO (Belgium).

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