ACHIEVEMENTS OF THE EUROPEAN RESEARCH PROJECT ADIGMA ON ADAPTIVE HIGHER ORDER METHODS FOR AEROSPACE APPLICATIONS

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Abstract

Computational Fluid Dynamics (CFD) has become a key technology in the development of new products in the aeronautical industry. However, despite the progress made in CFD, in terms of user time and computational resources, large scale aerodynamic simulations of viscous high Reynolds number flows are still very expensive and time consuming, stressing the need for novel methods.

Within the 3rd Call of the 6th European Research Framework Programme, the research project ADIGMA was initiated. The main objective of the ADIGMA project was the development and utilization of innovative adaptive higher-order methods for the compressible flow equations enabling reliable, mesh independent numerical solutions for aerodynamic applications in aircraft design. A critical assessment of the newly developed methods for industrial aerodynamic applications allowed the identification of the best numerical strategies for integration as major building blocks for the next generation of industrial flow solvers. The ADIGMA consortium gathered the main European aircraft manufacturers, the major European research establishments and several universities, all being well recognized for playing an active role in the development and utilization of advanced high fidelity CFD methods for aerodynamic applications. The technical work in ADIGMA was split into 5 work packages. In the first one industrial partners specified the requirements and the evaluation procedure for the methods newly developed. A test case suite of increasing complexity was specified including the necessary data in order to provide a firm basis for comparison at midterm and the end of the project. The main work package aimed at the improvement and enhancement of higher-order methods for aerodynamic applications. Several alternative strategies were investigated. Shortcomings and limitations of these rather new methodologies for industrial use had been addressed. Since computational efficiency is a crucial aspect for higher-order methods, a specific work package was dedicated to the development of solution strategies which meet the industrial requirements in terms of memory storage, computing time and efficient utilization of parallel low cost computers. The effectiveness and reliability of adaptation techniques in combination with higher-order methods were covered in a different work packages. New approaches were developed in order to achieve accurate flow features and flow quantities with minimal amount of degrees of freedom and computation time. The final work package addressed the critical assessment of the methods and technologies developed in ADIGMA under the specific aspect of a later industrial use for complex aerodynamic problems. The assessment was based on the evaluation plan and the test case suite defined in the first work package. The test cases covered different geometrical and physical complexity. The results were compared with reference data generated by well established state-of-the-art industrial codes.

The results achieved within the project clearly demonstrate the high potential of adaptive higher-order methods but they also indicate limitations and open issues still to be tackled. The ADIGMA project (September 2006 – December 2009) is seen as an important corner stone to fully exploit the potential of Computational Fluid Dynamics as the major source for determination of data required to drive the aerodynamic design process and a key enabler for meeting the strategic goals of future air transportation as specified in the ACARE Vision 2020 Report. The present paper gives on overview of the goals and main achievements of the collaborative research project.