ESMORGA: Exploiting Superconvergence in Meshes for Optimal Representations of the Geometry with high Accuracy

Description

High-fidelity simulations using supercomputers play a key role in aerospace and automotive design for reducing the number of ground and in-flight tests. The mesh lies at the heart of the simulation: it reproduces the geometry using elements that, for engineering applications, are required to be curved (high-order).

This project exploits geometric superconvergence: extra accuracy using lower order elements. The main goal is to transform observed geometric superconvergence into theory. The originality of this work is to derive the mathematics behind geometric superconvergence including theoretical limits and to develop a parallel code for High Performance Computing (HPC). The action features a two-way transfer of theoretical and practical knowledge between the fellow and the host institution in the topics of superconvergence, high-fidelity geometry simulations and HPC. The fellow will be integrated in the internationally recognized Geometry and Meshing for Simulation group at the Barcelona Supercomputing Center (BSC). This action is devised to have significant impact on the fellow's career, becoming an expert in superconvergence both for numerical approximations and geometry within the unstructured highorder simulations community focused on aircraft design. The proposal has the potential to establish the fellow as core scientist in the emerging research area of superconvergence and high-fidelity flow simulations, allowing the candidate to start and lead a new research group.

The work packages and methodology have been devised to reach the goals on high-fidelity geometry for simulation including parallel implementation for large data clustering. A risk assessment plan has been designed ensuring that at least suboptimal superconvergence theory can be derived. The BSC infrastructure will be essential for the implementation of this high-fidelity geometry tool; it houses MareNostrum4, one of the most powerful supercomputers in Europe.

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