Low-cost robust methodologies for computationally-demanding industrial problems

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ABSTRACT

Daily industrial practice requires fast and robust strategies to solve computationally-demanding problems. For instance, efficient strategies are needed to compute multiple queries of complex multi-physics and multi-disciplinary problems. Multiple queries are typical of parametric studies such as flow control, shape design or optimization, real-time monitoring of manufacturing processes and inverse analysis in medical imaging.

Reduced order models are typical alternatives for fast multiple query studies. In recent years, the proper generalized decomposition has gained attention in the industrial environment as a reduced order model because it presents attractive features. In particular the ability to construct offline a reduced basis for the parametric problem under analysis with no a priori knowledge of the solution, but, more important, the inexpensive online particularization of the generalized solution for a specific set of parameters, only via interpolation and without any extra resolution step. Several examples will be presented in particular for flow and magnetic resonance imaging.

However, in order to make such procedures affordable and competitive in a daily production environment, low-cost robust methodologies play a crucial role. Because industry prefers and is used to low order approaches. Devising novel solvers feasible to simulate different physical phenomena and robust to the choice of the underlying computational grid is critical. In this context, the face-centered finite volume (FCFV) method has been recently introduced [1, 2]. FCFV is able to perform efficiently large-scale simulations on complex unstructured meshes, is robust to cell distortion and stretching, provides first-order accurate approximation of the stresses without the need of flux reconstruction procedures, is locking-free in the incompressible limit and does not require any shock-capturing technique to compute non-oscillatory approximations of shock waves. The potential of the FCFV discretization paradigm to treat computationally-demanding industrial problems will be described using examples including thermal and elastic phenomena, as well as incompressible and compressible flows.

REFERENCES

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