"GPU accelerated linear algebra packages/solvers for large scales simulations using heterogenous clusters"

MS75 advanced HPC algorithms for large scale simulations

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The present work aims to improve the HPC performance of open-source codes commonly employed in the CFD and FEM domain by using GPU-enabled external linear algebra packages. Specifically, the open-source frameworks OpenFOAM® and Code-Aster will be considered, respectively, in the domain of computational fluid dynamics and mechanics. These codes have been widely used by academia and industry and deliver good parallel performance in massively parallel clusters up to tens of thousands of cores [1,2].

The GPU-enabled linear algebra packages AMGx by Nvidia [3], PETSc [4], and Chronos [5], suitable for heterogeneous HPC architectures, will be employed to improve HPC performance of such frameworks. Performance and portability will be compared on both standard/academic benchmarks [6] and more industry-relevant use-cases of increasing complexity, by using a state-of-the-art HPC heterogeneous cluster available to the scientific and industrial community.

REFERENCES

[1] S. Bnà, I. Spisso, M. Olesen, G. Rossi *PETSc4FOAM: A Library to plug-in PETSc into the OpenFOAM Framework*, PRACE White paper
[2] Code_Aster, Structures and Thermomechanics Analysis for Studies and Research, www.code-aster.org/
[3] M. Martineau: "OpenFOAM with GPU Solver Support", 9th ESI OpenFOAM Conference, 20 October, 2021.
[4] R. T. Mills et. Al: "Toward performance-portable PETSc for GPU-based exascale systems", Journal of Parallel Computing, 2021, http://hdl.handle.net/10754/672463.
[5] G. Isotton, M. Frigo, N. Spiezia, C. Janna. Chronos: A general purpose classical AMG solver for high performance computing. SIAM Journal of Scientific Computing, 43, pp. C335-C357, 2021
[6] https://develop.openfoam.com/committees/hpc