Contribution ID: **476** Type: **Poster**

GP-GPU for DFN flow simulations

Thursday, 17 May 2018 13:15 (15 minutes)

The present work proposes the use of General-Purpose Graphics Processing Units (GP-GPUs) to solve flow problems in large scale Discrete Fracture Networks (DFNs). Discrete fracture networks are randomly generated sets of planar polygons in the three dimensional space resembling the fractures in the subsoil. Recently a minimization approach was developed to tackle the issue of effective flow simulations in intricate networks of fractures [1,2,3,4]. If the minimization problem is solved via a gradient based approach, the computation of the descent direction at each iteration requires several matrix-vector operations that involve quantities related to each fracture in the network and that can be performed in parallel. Thus, the use of GPUs appears very promising to accelerate computations. In this context, one of the principal bottlenecks consists in the communications between the GPU and the main-board through the bus PCI-Express. The code is organized in a way that minimizes these communications, allowing, at the same time to optimize the use of all cores in the graphic unit when performing floating-points operations. The code has been developed for GPUs with CUDA (NVIDIA) architecture using the cuSparse and cuBlas libraries to handle operations on both sparse and dense matrices. Experiments show that maximum speed-ups are mainly affected by the number of intersections in the considered DFNS with speed-ups approaching 20x in networks with a large number of intersections.

References

[1] S. Berrone, S. Pieraccini, and S. Scialò, A PDE-constrained optimization
formulation for discrete fracture network flows, SIAM J. Sci. Comput. 35 (2013), B487–B510.

[2] S. Berrone, S. Pieraccini, S. Scialò, An optimization approach for large scale simulations of discrete fracture network flows, J. Comput. Phys. 256 (2014)
838–853
[3] S. Berrone, S. Pieraccini, S. Scialò, F. Vicini, A parallel solver for large scale DFN flow simulations, SIAM J. Sci. Comput. 37 (3) (2015) C285-C306
[4] S. Berrone, S. Pieraccini, and S. Scialò , Non-stationary transport phenomena in networks of fractures: Effective simulations and stochastic analysis, Computer Methods in Applied Mechanics
and Engineering 315 (2017), 1098 -1112.

Acceptance of Terms and Conditions

Click here to agree

Primary authors: BERRONE, Stefano (Politecnico di Torino, Italy); Mr D'AURIA, Alessandro (Politecnico di Torino); Dr PIERACCINI, Sandra (Politecnico di Torino); Dr SCIALO, Stefano (Politecnico di Torino); VICINI, Fabio (Politecnico di Torino)

Presenter: VICINI, Fabio (Politecnico di Torino)

Session Classification: Poster 4

Track Classification: MS 2.03: Challenges in flow and transport simulations in poro-fractured media: numerical methods and modeling