Project Team INRIA: **HiePACS**

Author of the post-doctoral research subject:
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Title of the post-doctoral research subject:
Parallel Geometric Full Multigrid Solver

Scientific priorities:
Computing the future: models, software and numerical systems
Calculer le futur : modèles, logiciels et systèmes numériques

Scientific Research context:

In many large scientific and industrial applications, one has to solve large sparse linear systems that arise from the discretization of a PDE on complex geometries. For some applications, such as the wave equation solution in the frequency domain, a rather coarse mesh generated by a suited mesh generator is often enough to well capture the complex geometry of the object of interest. However, for physical reasons a much finer mesh is required to properly represent the physical phenomenon. In that framework, parallel geometric multigrid solution techniques appear as excellent candidate solvers for the solution of the linear or nonlinear problem associated with the PDE. Not only the solution, but the mesh generation (via isotropic mesh refinement) can be performed in parallel. Furthermore, using state of the art parallel sparse direct solvers such as PasTiX, the parallel solution of the coarse space problem with a few millions of unknowns is tractable on a few hundreds of cores. In that context, only a few multigrid levels are often enough to solve huge problems while ensuring the robustness of the overall solver.

In a recent work, we investigated such a numerical technique for the solution of the Maxwell equation in the frequency domain with some success (1.3 billion problem on a non canonical geometry using 1024 cores). However some further investigations of some numerical and computational parts of our solution scheme deserve to be undertaken to enhance its robustness and parallel efficiency. Furthermore, the solution scheme should be validated in different application contexts for other type of PDE problems.

Post-doctoral researcher work description:

The candidate will primary study possible alternatives to the mesh refinement strategies and possible alternative for the parallel data distribution. In a second stage, based on the conclusion of this first action, she/he will contribute to the design of a flexible parallel generic software platform enabling to easily investigate the relevance of the solver on various PDE problems. The robustness of the design of these parallel numerical schemes will be assessed on large challenging applications and the simulations will be performed on large computing platforms.
These research activities will be conducted in the framework of the joint Inria-CEA research initiative started in 2012.

Required knowledge and background:

The successful development of the scientific work described above requires a strong background in parallel computing and computational sciences; therefore a PhD in computational sciences (applied maths and/or computer science) would be ideal.
A strong interest in large-scale numerical simulation and parallel computing would surely be an additional asset.

References:

[1] A.H Baker,. R.D. Falgout, T.V. Kolev, T.V. and U.M. Yang, Multigrid smoothers for ultraparallel computing, SIAM Journal on Scientific Computing, 33 (2011), pp. 2864–2887

[2] M. Chanaud, L. Giraud, D. Goudin, J.J. Pesqué et J. Roman, A Parallel Full Geometric Multigrid Solver for Time Harmonic Maxwell Problems, (devrait être disponible en tant qu'Inria scientific report lors de la parution de cette offre)

Keywords: Parallel computing, multigrid solver, parallel sparse direct solver.

Duration: 16 months