INTERNSHIP PROPOSAL

SCALABLE LINEAR SOLVERS FOR GEOMECHANICS

ELECTROTECHNICS AND MECHANICS DEPARTMENT

Context

The Electrotechnics and Mechanics Department of EDF R&D has been developing computational software for mechanical and electrotechnical researches for more than twenty years. Its most impacted software, code_aster, is an open source finite element solver and is distributed within the Salome_Meca platform (www.code-aster.org).
The background of the internship is the modeling of thermo-hydro-mechanical problems (THM), which describe the behavior of a soil, represented as a porous medium within which evolves a weakly compressible fluid. This is the Biot's consolidation problem or poro-elasticity problem [1, 2]. This framework is used for instance for studying dams in their environment and the storage of nuclear wastes in the underground.

Goals

Important work has been done on iterative solvers for structural mechanics over the past years. The ability of multigrid methods to solve in a scalable manner standard mechanical problems (not involving Lagrange multipliers i.e. resulting in symmetric positive definite systems) was notably highlighted [3]. However, in the case of the Biot's problem, the linear systems to be solved are not definite positive.
Preliminary work has been carried out in EDF R&D on a simplified version of these equations, involving mechanics of solids, hydraulics and thermics. The method developed in code_aster intensely exploits a multigrid algorithm in a block preconditioning algorithm. Numerical results on a model problem and more realistic problems reflect the good performance of the proposed preconditioner.
The main goal of the internship consists in extending the approach to the use of a regularization technique which is often mandatory to gain robustness, while introducing new degrees of freedom [4]. The efficiency of the method will be evaluated on large scale industrial problems.

The internship shall result in a PhD of 3 years with EDF R&D.

Required Educational Background

- Master 2 in applied mathematics or scientific computing
- Knowledge in Mechanics
- Skills : linear algebra, finite element software, C and Fortran, Linux

Practicalities

- Duration : 6 months
- Location : EDF R&D, Saclay in Paris south suburb
- Salary net per month : from 700 to 1000 €
- Contact : Nicolas Tardieu – Research engineer

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References

[1] *General Theory of Three-Dimensional Consolidation* - Maurice Biot, Journal of Applied Physics, 12(2), Pages 155–164, February 1941
[2] *Poromechanics* - Olivier Coussy, Wiley, 2004
[3] *Multigrid Methods* - Stephen F. McCormick, Society for Industrial and Applied Mathematics, January 1987
[4] *A simplified second gradient model for dilatant materials: Theory and numerical implementation* - Roméo Fernandes, Clément Chavant, René Chambon, International Journal of Solids and Structures, Volume 45, Issue 20, 1 October 2008, Pages 5289-5307