Master 2 or Engineering degree Internship proposal in applied mathematics at R&D EDF and LJAD

Job proposal : 6 month internship
Degree : Master 2 or engineering degree
Skills : Numerical analysis and scientific computing
Duration : 6 month between February and September 2017
Gratification : Depends on the background
Location : Laboratoire de Mathématiques LJAD, Université de Nice Sophia Antipolis
Region : Provence-Alpes-Côte d’Azur

Context
Within the R&D of EDF, the LNHE department (Laboratoire National d’Hydraulique et Environnement) is studying the impact on the environment of the industrial facilities. In this framework, the team in charge of hydrogeological studies develops simulation tools to model the flows in the neighbourhood of industrial facilities. These simulations are performed using the SALOME platform (http://www.salome-platform.org) for the pre and post processing as well as the « Groundwater Flow » module of Code_Saturne (http://code-saturne.org) for the processor. Code_Saturne, developed by the MFEE department, is the reference code at EDF R&D for computational fluid dynamics. The soil moisture content, the pressure and the velocity of the groundwater flow are obtained using the Richards equation. The simulations are based on the finite volume discretization and are performed in parallel on distributed architectures.

Research topics
After a finite volume discretization in space and an Euler implicit time integration of the Richards equation, one needs to solve, by a Newton type algorithm and at each time step of the simulation, a large non linear system coupling the liquid pressure and the soil moisture content (or saturation) unknowns on the full mesh of the computational domain. These non linear systems are difficult to solve on practical industrial problems due to
- the strong non linear coupling of the liquid pressure and saturation unknowns related by the Van Genuchten capillary pressure laws
- the strong heterogeneities of the porous medium including the ground as well as the civil engineering parts
- the large size and complexity of the mesh
The objective of the proposed internship is to improve the robustness of the non linear solver starting from the recent work of (Brenner K., Cancès C., 2016) which has shown that using a smart definition of the primary unknown improve considerably the robustness of the Newton solver.

The intern will study and implement this new algorithm combined with the Vertex Approximate (VAG) finite volume discretization (Xing F, Masson R., Lopez S, 2016) of the Richards equation. The VAG scheme is based on both node and cell unknowns and is adapted to polyhedral meshes as well as heterogeneous and anisotropic porous media. The algorithm will be tested and compared with classical approaches on realistic test cases including heterogeneities and anisotropy of the medium and non conformity of the mesh.

Required skills
Applicants should come from a Master 2 in applied mathematics, or an engineering degree with a specialization in applied mathematics. They should have a good knowledge of the discretization of partial differential equations and be familiar with a scientific programming language such as Fortran or C or C++.

Contacts
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