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An efficient solver based on logically rectangular meshes for Biot's consolidation model

Javier Zaratiegui, **Carmen Rodrigo**[1], **Andrés Arrarás**, **Laura Portero**[2]

SUMMARY

The study of poroelasticity is of great interest in many societal relevant applications such as geothermal energy extaction, CO_2 storage or hydraulic fracturing, among others. In these models, there is a coupling between the fluid flow and solid deformation within a porous medium. Maurice Biot established in [1] a general three-dimensional mathematical formulation for these problems. When it comes to modeling real applications, numerical simulation becomes mandatory. Consequently, an intensive research has been carried out in the development of efficient discretizations as well as solution methods for the algebraic system that arises from Biot's poroelasticity model.

In this work, we consider a discretization of the quasi-static Biot's model based on the multipoint stress-multipoint flux mixed finite element method introduced in [2], which is locally conservative and can be formulated on simplicial and quadrilateral meshes. Moreover, it can handle accurately discontinuous full tensor permeabilities and Lamé coefficients, whose are the most common case related to subsurface flows.

The discrete scheme for Biot's model yields large systems of algebraic equations, so that its solution is a crucial aspect in numerical simulation, due to the fact that there is a huge computational cost involved in it. There are two main strategies employed to deal with the solution of such systems: monolithic methods and iterative coupling methods. In this talk, we will comment on these strategies and an efficient solver based on logically rectangular meshes for this problem will be proposed. This type of meshes improve the overall performance when structured data is used, since they take advantage of recent computer architectures. Finally, the robustness of the new solver is illustrated by presenting numerical results.

Keywords: poroelasticity, Biot's model, solver

AMS Classification: 65F10, 65N30, 65N20

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[1]Department of Applied Mathematics & IUMA
University of Zaragoza
email: javierzu@unizar.es, carmenr@unizar.es

[2]Department of Statistics, Computer Science and Mathematics & INAMAT-2
Public University of Navarre
email: andres.arraras@unavarra.es, laura.portero@unavarra.es