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Rationalised computational time in fracture simulation: adaptive model reduction and domain decomposition

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ABSTRACT

In early stage design in engineering, it is common to have to solve large mechanical problems many times, varying the input parameters. This is done to check the effect each parameter can have on the system. This can be a very time-consuming analysis. Model order reduction(MOR) is one way to reduce significantly the computational time by reducing the number of unknowns. This is done by looking for the solution in a reduced space spanned by only a few well-chosen basis vectors. It was applied for characterization of human faces back in 1987 by Sirovitch *et al.*[1]. In the context of solid mechanics involving material nonlinearities, this method performs poorly because any small perturbations of the problems parameters has the effect of changing significantly the evolution of the fracture, hence requiring a large number of global basis vectors. Ryckelynck *et al.* [2] and Kerfriden *et al.* [3] tackled this issue by performing global corrections of the basis vectors during the computation. These schemes can however be prohibitively expensive as they are based on global evaluation of the error over the domain. In this paper, we will by-pass the difficulty by coupling MOR together with domain decomposition methods (DDM). DDM are described in for example [4]. The essential idea of DDM is that the domain studied is divided into several subdomains leading to independent subdomains that can be solved independently. Using this framework, the fracture will be isolated on some subdomains, allowing us to apply MOR on all the other subdomains, which do not undergo high non-linearities. It is also a way to speed-up the computations since parallel computing can be used.

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