POD-based Reduction Methods, the Quasicontinuum Method and their Resemblance

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Keywords: *interpolation, reduced integration, multiscale, quasicontinuum method, reduced-order modelling, proper-orthogonal-decomposition*

Large mechanical simulations are computationally inefficient, because they come with

1. large numbers of degrees of freedom (and hence, the solution of large systems), and
2. large numbers of integration points that need to be visited to construct these large systems.

These two issues are especially problematic for nonlinear problems, because they both occur for each increment, for each iteration. Parallel computations on clusters can be used to speed up large nonlinear simulations. Alternatively, numerical strategies can be employed. In this presentation, two numerical reduction approaches will be considered, including their resemblance. The first category consists of reduced order modelling approaches based on proper-orthogonal-decomposition (POD). The second is the multiscale quasicontinuum (QC) method.

Both methods aim to reduce the large number of degrees of freedom by interpolation (avoiding issue (1)). They also select only a few integration points to sample the contributions of all integration points (avoiding issue (2)). POD methods are broadly applicable, but require many full-scale computations to be performed before they can be applied. Furthermore, relatively few procedures to select the reduced integration points exist [1-2], although we have recently made some contributions in this field [3]. The multiscale QC method on the other hand does not require full-scale computations to be performed a-priori. Also, the application of Dirichlet boundary conditions is more straightforward and the selection of reduced integration points is studied more extensively [4-7]. An important disadvantage of the QC method is that it can only be used for regular lattice computations up till now.

References

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