A multiscale partitioned reduced order model applied to damage simulation

Olivier Goury[1]**, Pierre Kerfriden**[1]**, Stéphane P. A. Bordas***[1]
[1] Cardiff University, Queen's Buildings, The Parade, Cardiff, CF24 3AA

Key Words: *Model order reduction, domain decomposition method, fracture mechanics.*

ABSTRACT

Simulating fracture in realistic engineering components is computationally expensive. In the context of early-stage design, or reverse engineering, such simulations might need to be performed for a large range of material and geometric parameters, which makes the solution to the parametric problem of fracture unaffordable. Model order reduction, such as the proper orthogonal decomposition (POD) [1], is one way to reduce significantly the computational time by reducing the number of spatial unknowns. The solution is searched for in a reduced space spanned by a few well-chosen basis vectors only. In the context of solid mechanics involving structural softening, the strong topological changes in the zone where damage localises are extremely sensitive to variations of the parameters, which requires reduced spaces of prohibitively large dimensions in order to approximate the solution with a sufficiently high degree of accuracy. Introduced in [1], partitioned model order reduction is an alternative to global model order reduction that essentially divides up the problem into smaller regions. Each region can then be tackled using a reduced model of appropriate size, if at all, depending on the local material non-linearities in the region. In the context of multiscale homogenization, simulations of representative volume elements (RVE) have to be performed to obtain the material properties in the different elements of a coarse mesh. When considering a nonlinear material, those multiple RVE simulations can be computationally very expensive. They however only differ by the history of boundary conditions applied. This contribution proposes to apply partitioned model order reduction to those RVEs with reduced bases parametrized by the boundary conditions.

REFERENCES

[1] P. Kerfriden, O. Goury, T. Rabczuk, S. Bordas, A partitioned model order reduction approach to rationalise computational expenses in nonlinear fracture mechanics, *Computer Methods in Applied Mechanics and Engineering*, **256**:169–188, 2013.

[2] C. Farhat, F.X. Roux, A method of finite element tearing and interconnecting and its parallel solution algorithm, *International Journal for Numerical Methods in Engineering.*, **32**:1205–1227, 1991.