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Towards a concurrent multiscale model in Peridynamics adopting a variable grid spacing

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Concurrent multiscale modelling is gaining an increasing attention due to its capabilities to study, in a single framework, phenomena at different length scale. This topic is particularly important for the simulation of crack propagation in heterogeneous materials as, for example, nanocomposite materials. In this case, due to the complexity of the phenomena involved and the necessity to consider the scale effect, the nanofiller interaction and the behaviour of the matrix-nanofiller interface, a multiscale approach is mandatory. Before studying such a complex problem, it is necessary to develop a robust multiscale scheme able to manage crack propagation in homogeneous material.

Our work will use the Peridynamics (PD) theory [1] to propose a multiscale method based on grid refinement inspired by the Splice concept [2] and by the FEM-PD coupling approach described in [3]. Even though the method is free of ghost forces in static problems, the presence of spurious waves at the interface between different grid spacings is observed in dynamic problems.

Wave propagation in a homogenous body is studied using denser grids in localized areas; we will compare the solutions of dynamic problems produced by the proposed method with those generated by PD models, which use a constant horizon and a uniform grid. The spurious effects will be characterised as a function of grid spacing, m-ratio and influence function variations. We will show that the same accuracy is obtained at a much smaller computational cost. The method can be also equipped with the capability to change, in an adaptive way, the grid spacing to follow the areas subjected to high strains. The new computational technique will show its capabilities to study, in an efficient way, also problems involving cracks interaction. The proposed method paves the way for the implementation of a concurrent multiscale approach in the framework of the PD theory.

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