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The use of error estimators for adaptivity in non-ordinary state-based peridynamics

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Peridynamics (PD) is a non-local formulation defined in integral form rather than the conventional partial derivative from continuum mechanics [1]. This feature makes it possible to use the same formulation whether a discontinuity is present or not in the numerical model, in contrast to other numerical methods used in fracture mechanics, such as the finite element method (FEM). The PD formulation is attractive because it enables the modelling of difficult patterns in crack propagation problems such as crack branching in a simple way, since no additional assumptions are necessary in the PD framework.

In order to capture the crack propagation, it is necessary to have a reasonable number of particles around the crack tip (or the region where a crack initiates). Additionally, a uniform distribution of the particles is necessary in order to avoid spurious wave propagation in the domain [2]. However, the non-locality of the PD method also imposes a computational efficiency problem, since each particle has an area of influence known as its horizon, and each particle in this region has some influence in the response of a given central particle. It would be more interesting to increase the number of particles where needed only.

In this work we propose a formulation for adaptivity in PD with techniques previously used in FEM problems. A background FE mesh is used to define the particle positions and also to obtain the horizon of each particle. Then an *a posteriori* error estimator [3] is modified to be used in dynamic analysis. The error estimator indicates the regions where particle refinement is necessary, as well as regions where too many particles are present and can be coarsened. We present some examples illustrating how the adaptive scheme improves the computational efficiency without compromising the analysis results.

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