Adaptive remeshing technique for discrete static models of fracture

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ABSTRACT

Discrete representation of materials is a natural alternative to continuous approaches. A collection of interconnected rigid cells organized into a net structure is often called a discrete or lattice model. Lattice models are being used in several versions; we focus here only on *static* models with lattices of *random geometry* based on Voronoi tessellation, such as [1, 2].

The extremely fine discretization of the discrete model leads to extreme computational demands, however it is often necessary; especially when it is related to meso-scale structure of the simulated material. The contribution presents a technique to adaptively refine model discretization (called shortly adaptive remeshing), that will allow updating discretization during the simulation run in the area where the crack propagates. Without this tool, it is necessary to densely discretize the whole domain and therefore to create computationally demanding model.

Availability of adaptive remeshing allows starting simulation with rough discretization and refining it adaptively as the crack initiates and propagates. Successful attempts to introduce this important feature already exist [3, 4]. They are based on adaptive replacement of some continuous model with the discrete one, but problematic interface between continuum and discrete model is involved and the discrete model has to have regular geometry (that produces directional bias).

Another approach is proposed here. The adaptive remeshing is performed within the discrete lattice model only and allows using irregular geometry based on Voronoi tessellation. The algorithm works as follows. Initially, the whole domain is roughly discretized. Whenever any bond of the rough model exceeds some limit of equivalent strain, discretization in its vicinity is replaced by finer one and some transitional area connecting the rough and fine discretization is inserted around. The problematic part of replacing the discretization can be simply solved by adding new nuclei into region of interest and updating the Voronoi tessellation. The rest of the domain tessellation will remain the same.

Comparison of adaptively discretized and fully densely discretized models is provided in the contribution.

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