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Conforming Voronoi Meshing for three dimensional domains with multiple cracks

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Abstract

We present a conforming Voronoi meshing algorithm for three-dimensional domains with multiple cracks to support modeling and simulation of carbon sequestration processes at specific geologic sites. A Voronoi mesh is required to be non-regular to mimic properties found in geologic fracture systems. Based on a uniform distance function, our algorithms starts with generating a bias-free random point cloud within the domain boundaries. This bias-free feature is crucial for simulations of propagating cracks since it minimizes the effect of the tessellation on the direction of the crack growth. The generated point cloud satisfies the requirements of maximal Poisson sampling, leading to a conforming Voronoi mesh with guaranteed angle bounds. The presented algorithm is linear in the number of generated points and can be efficiently implemented in parallel. A two-dimensional serial implementation of this algorithm is capable of generating a tessellation with one-million points in less than 20 seconds. Several two-dimensional examples are presented below to show the capabilities of this new approach.

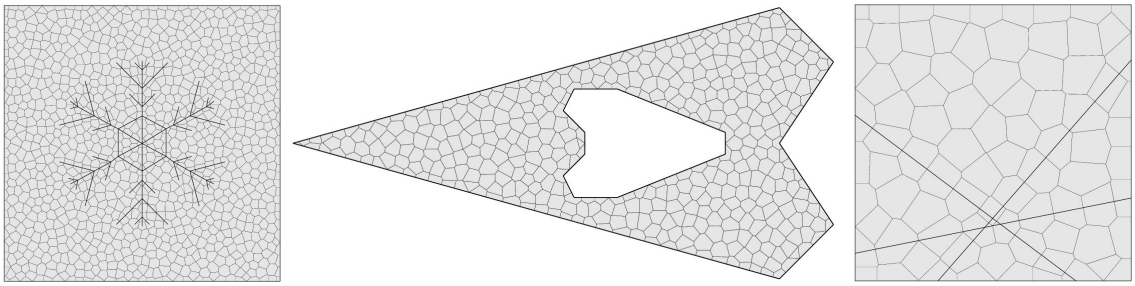

Fig. 1: Conforming Voronoi Tessellations based on a uniform distance function for a square domain with internal boundaries (left), a non-convex domain with a hole (middle) and a square domain with multiple regions in contact (right). A serial implementation of our algorithm is capable of distributing 100,000 random points/second and tessellating the output point cloud at a rate of 250,000 points/second

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