The meccano method for generation of high-quality adaptive meshes over complex terrains

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Abstract

The meccano method was introduced in [1], to construct simultaneously tetrahedral meshes and volumetric parameterizations of solids. This method [2,6,9] requires the information of the solid geometry that is defined by its surface, a meccano, i.e. an outline of the solid defined by connected polyhedral pieces, and a tolerance that fixes the desired approximation of the solid surface. The method builds an adaptive tetrahedral mesh of the solid (physical domain) as a deformation of an appropriate tetrahedral mesh of the meccano (parametric domain). The main stages of the procedure use an admissible mapping between the meccano and the solid boundaries, the construction of a coarse tetrahedral mesh of the meccano, the nested Kossaczky's refinement and our simultaneous untangling and smoothing for the resulting tetrahedral mesh after the movement of the boundary nodes of the meccano to the solid surface. This last algorithm has been implemented in parallel by using shared or distributed memory [4,10]. In this talk, we use the method to mesh a 3-D domain that is limited in its lower part by a complex terrain, and in its upper part by a rectangle placed at a given height, see details in [8]. A digital elevation map of the terrain and the required orography approximation are given as input data. The meccano consists on a simple cuboid whose upper face coincides with the upper boundary of the domain, and its lower face is placed at the minimum terrain height. To construct a coarse tetrahedral mesh of the meccano, a uniform subdivision into cuboids is done attending to user specifications and each cuboid is subdivided into six tetrahedra. The mapping between the meccano and domain boundaries can be obtained by a vertical projection or applying an automatic Floater's parameterization of compatible surface triangulations of the six faces of the domain. The meccano method constructs high-quality and adaptive tetrahedral meshes with a minimum intervention of users, see example Figure 1(a). The method has been extended to construct adaptive T-meshes that are suitable for isogeometric analysis [3,5,7], see example in Figure 1(b). In this case, an octree subdivision technique and a simultaneous untangling and smoothing of T-meshes are involved.

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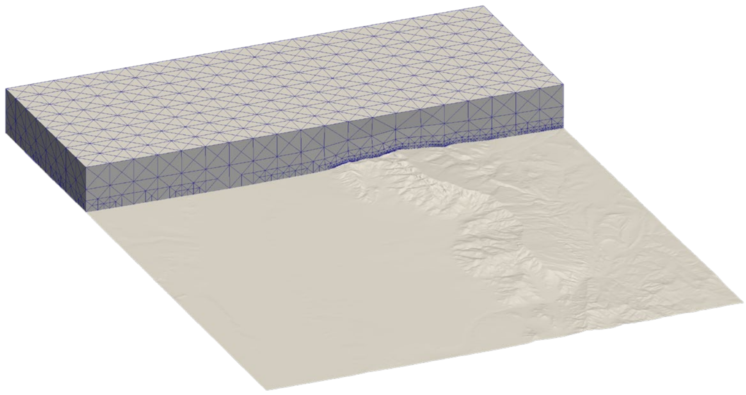
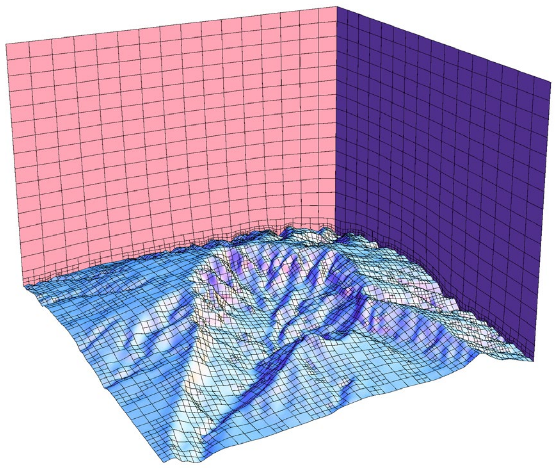


(a)



(b)

Figure 1. Example of a tetrahedral mesh (a) and a T-mesh (b) over complex terrain.