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High order unstructured curved mesh generation using the Winslow Equations

Meire Fortunato[1]* and Per-Olof Persson[2]

[1] University of California - Berkeley, CA - meirefortunato@berkeley.edu
http:/math.berkeley.edu/~meiref
[2] University of California - Berkeley, CA - persson@berkeley.edu
http://persson.berkeley.edu

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We propose a method to generate high order unstructured curved meshes using the classical Winslow equations [1]. We start with an initial straight-sided mesh in a reference domain, and set the position of the nodes on the boundary to be on the true curved geometry. Inside the domain, we solve the Winslow equations using a continuous Galerkin finite element discretization. This formulation appears to produce high quality curved elements, which are highly resistant to inversion. In addition, the corresponding non-linear equations can be solved efficiently using Picard iterations, even for highly stretched boundary layer meshes. Compared to the previously proposed technique of nonlinear elasticity [2], this could reduce the computational cost by large amounts without significant differences in the resulting meshes.

We show a number of examples in both two and three space dimensions, including complex geometries and boundary layers. We compare the results with other approaches and study the behavior of the nonlinear solver.

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