EFFICIENT MESH GENERATION UTILIZING ADAPTIVE INITIAL GRIDS AND DOMAIN DECOMPOSITION PRECONDITIONERS

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ABSTRACT

To generate a mesh in a physical domain, an initial mesh of a polygonal domain that approximates the physical domain is introduced. An optimization problem by utilizing a mesh quality function is considered for the displacement on the initial body centered cubic (BCC) mesh points with constraints on the boundary of physical domain, which maintains a good quality of triangles while aiming at fitting the initial mesh to the boundary of the physical domain. The BCC mesh can give a more efficient node ordering for the matrix vector multiplication and the constraints are provided by the level set function of the physical domain [1]. The solution to the optimization problem can be obtained by using the Fréchet derivative of the objective function. The resulting nonlinear algebraic system can be solved by the Picard or Newton method. To handle a physical domain with a complex boundary such as a human organ or body, a very fine initial mesh is often required but the solution time for the nonlinear algebraic system becomes problematic. To overcome this limitation, adaptively refined grid cells for the initial BCC mesh can be used and the algebraic system in the Picard or Newton method can be solved efficiently by an iterative method using preconditioners [2,3]. The use of iterative solvers with domain decomposition preconditioners gives a parallel meshing algorithm that makes the proposed scheme more efficient for large scale problems. Numerical results for various test models are included.

REFERENCES

1. Teran, J., Molino, N., Fedkiw, R., and Bridson, R, ”Adaptive physics based tetrahedral mesh generation using level sets”, *Engineering with Computers*, Vol. 21, 2005, pp. 2-18.
2. Li, J., and Widlund, O. B, ”FETI-DP, BDDC, and block Cholesky methods”, *International journal for numerical methods in engineering*, Vol. 66.2 2006, pp. 250-271.
3. Kim, H. H., Chung, E., and Wang, J, ”BDDC and FETI-DP preconditioners with adaptive coarse spaces for three-dimensional elliptic problems with oscillatory and high contrast coefficients”, *Journal of Computational Physics*, Vol. 349, 2017, pp. 191-214.