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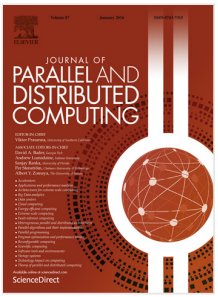

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Domain Decomposition Approach for Parallel Improvement of Tetrahedral Meshes

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SUMMARY

Presently, a tetrahedral mesher based on the Delaunay triangulation approach may outperform a tetrahedral improver based on local smoothing and flip operations by nearly one order in terms of computing time. Parallelization is a feasible way to speed up the improver and enable it to handle large-scale meshes. In this study, a novel domain decomposition approach is proposed for parallel mesh improvement. It analyses the dual graph of the input mesh to build an inter-domain boundary that avoids small dihedral angles and poorly shaped faces. Consequently, the parallel improver can fit this boundary without compromising the mesh quality. Meanwhile, the new method does not involve any inter-processor communications and therefore runs very efficiently. A parallel pre-processing pipeline that combines the proposed improver and existing parallel surface and volume meshers can prepare a quality mesh containing hundreds of millions of elements in minutes. Experiments are presented to show that the developed system is robust and applicable to models of a complication level experienced in industry.

KEY WORDS: parallel algorithms; mesh generation; quality improvement; domain decomposition; dual graph

1. INTRODUCTION

For numerical simulations with complex geometries, mesh generation typically represents a large portion of the overall analysis time. The ability to perform computations on tetrahedral elements has always been regarded as very important, since the meshing time required for them is usually at least an order of magnitude smaller than for hexahedral or other types of elements. The fundamental reason is related to the fact that tetrahedral elements can be automatically generated for complex geometries using a theoretically guaranteed procedure **[1-3]**, while this is not the case for other types of elements. The weakness of tetrahedral elements is that simulations on them may suffer from stability issues and need more elements given a similar node set. However, these difficulties

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