Efficient Parallelisation of an Unstructured Delaunay Triangulation

M. El Hachemi, O. Hassan, N. P. Weatherill and K. Morgan

Civil and Computational Engineering Centre
School of Engineering
Swansea University
Swansea SA2 8PP
Wales, UK
o.hassan@swansea.ac.uk

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ABSTRACT

In the last decades there has been a significant progress in numerical algorithms for the simulation of physical processes and a growing demand for efficient and powerful numerical codes for the industrial design and engineering. Therefore, the development of a fully automated, robust and fast parallel mesh generator has become a very important issue. Traditionally, two main techniques have been implemented to generate meshes in parallel. The first is based on the parallelisation of the Delaunay kernel while the second is based on the partitioning of the domain to be generated. Unstructured mesh generation methods have a large variation in the number of operations required during each generation process, therefore, domain partitioning, which allows independent triangulation of the individual sub-domains, provides a natural route to a successful parallelization of the mesh generation techniques. However, issues, such as the creation of the sub-domains, load balancing and communication costs, need to be addressed.

Here we present a recursive three dimensional Delaunay-based algorithm that produces partitioned domains which can be generated in parallel. The algorithm starts by the Delaunay triangulation of the boundary points. The initial triangulation is used to estimate the number of elements to be generated by integrating the user defined element spacing. A plane which partitions the estimated number of elements into two, nearly, equal regions is located along the longest axis. The vicinity of the plane is then refined using a modified point creation technique and the standard Delaunay kernel.

At the portioning process, points are created on edges which intersect the identified plane. The created points must comply with the defined spacing before being inserted into the Delaunay triangulation. A rough surface, formed by the assembly of the closest faces to the identified plane, is constructed and used as the interface between the two portioned domains, Figure 1. The new sub-domains are renumbered and one of them is sent to a newly spawned processor. These steps are repeated until the estimated number of elements inside each domain fits within a single processor.

The advantages of this efficient and easy to implement technique, over the conventional bisection methods, will be discussed. The quality of the generated mesh will be examined using some challenging industrial geometries.

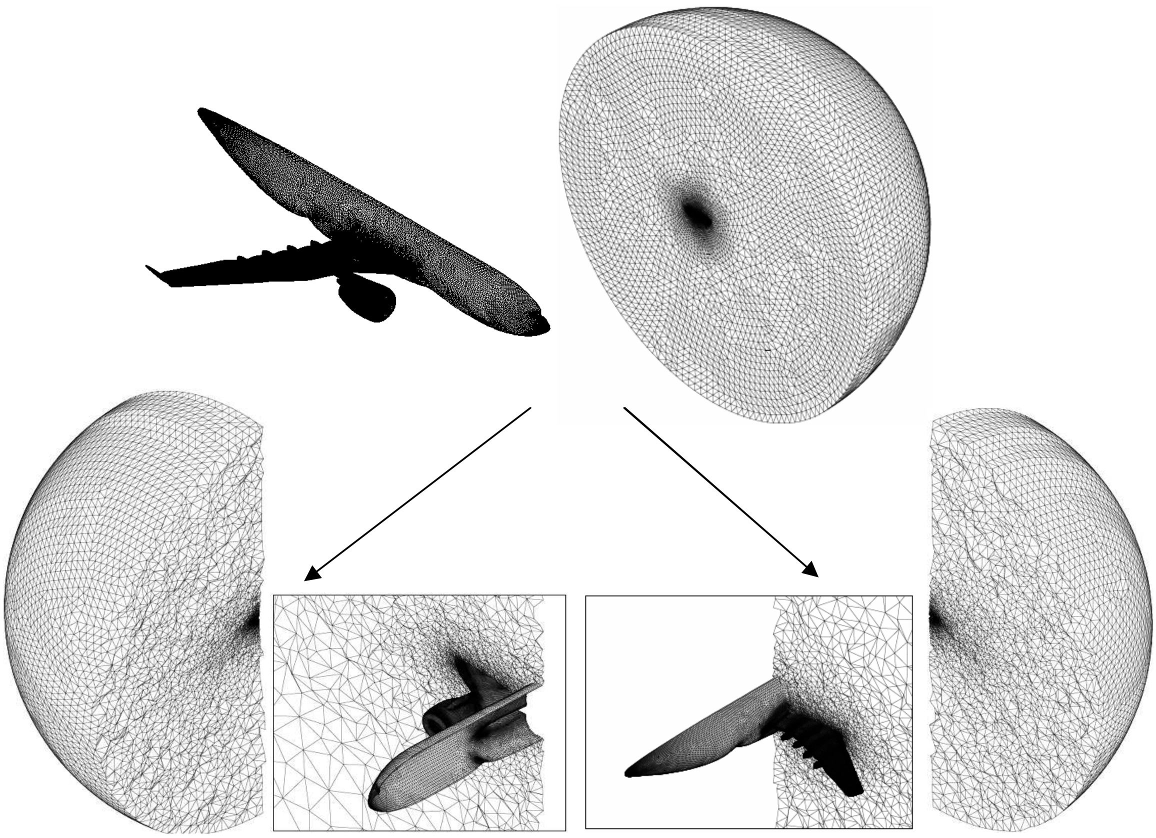

Figure 1: Domain partitioning using Delaunay-based technique.

REFERENCES

[1] N.P. Weatherill and O. Hassan, "Efficient three-dimensional Delaunay triangulation with automatic point creation and imposed boundary constraints" *International Journal for Numerical Methods in Engineering*, Vol **37**, pp. 2005-2039, (1994).

[2] R. Löhner, J. Camberos, and M. Merriam "Parallel unstructured grid generation" *Computer Methods in Applied Mechanics and Engineering*, Vol 95, pp. 343-357, (1992).

[3] A. Shostko and R. Löhner. Three-dimensional parallel unstructured grid generation. *International Journal for Numerical Methods in Engineering*, Vol. 38, pp. 905-925, (1995).