

PARALLEL MOVING UNSTRUCTURED MESHES FOR FLUID STRUCTURE INTERACTION

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Summary. This work is motivated by the success of the adaptive finite element methods in accurately simulating fluid and structure problems [5-7]. Moving rigid bodies in different fluid media is one of the main challenges that we meet when dealing with fluid structure interactions.

We focus in this paper on the dynamic displacement of complex body geometries, which are discretized with unstructured meshes (triangles in 2D and tetrahedron in 3D). Moving bodies inside a meshed domain often leads to large deformations that can invalidate the mesh. In practice, a combination of mesh deformation techniques with remeshing is considered to avoid the invalidity of the mesh. However, the remeshing mechanics can penalize the performance of the whole deformation process even when it is local.

We propose in this paper a fast parallel moving mesh algorithm that consists in:

1. Using a fast Inverse Distance Weight interpolation method [1] to propagate the imposed displacement on body nodes to volume nodes;
2. Extract and remesh only elements with bad quality with respect to a predefined threshold;
3. 1 and 2 are performed on a distributed mesh. We use algorithms developed in [2-5] to manage the remeshing part and we propose an efficient parallel approach to perform the interpolation part.

The proposed approach is then confronted with different 2D and 3D test cases for validation and performance analysis. For example, Figure 1 shows the history mesh evolution of a 3D rotating fan and Table 1 gives some statistics on the quality of the latest deformed mesh with respect to different thresholds.

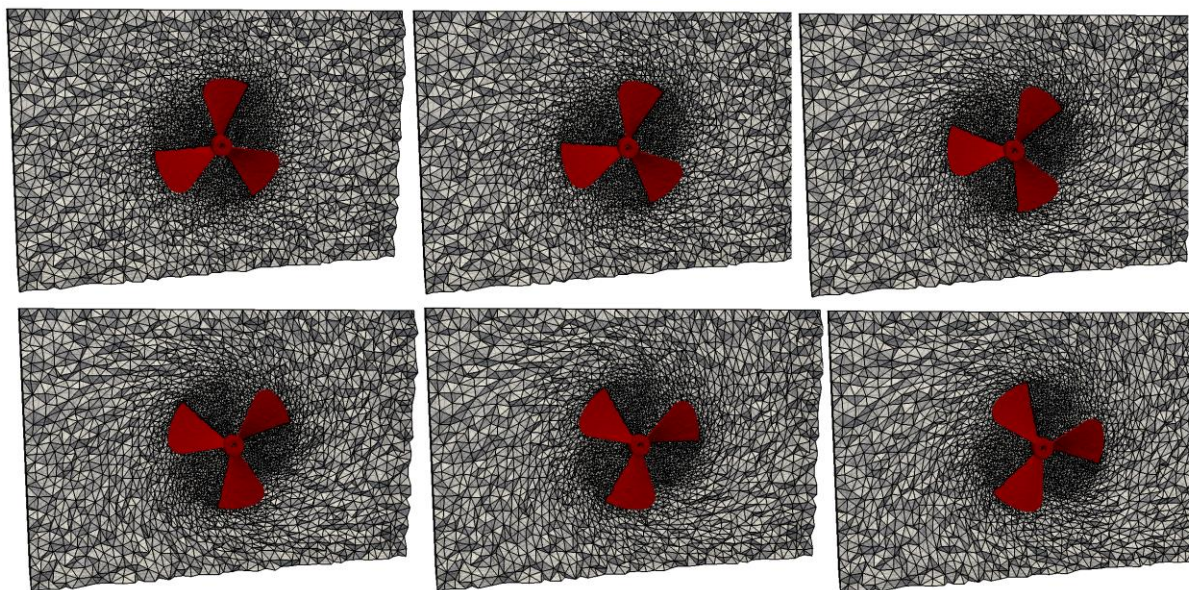


Figure 1: Evolutionary snapshots of a 3D Rotating fan with a quality threshold of 0.4.

Quality threshold	Average Quality	Worst Quality
0.4	0.71	0.29
0.5	0.73	0.31
0.6	0.74	0.35

Table 1 : Mesh quality statistics with respect to different thresholds for a 3D rotating fan.

More results and test cases will be given in the extended version.

REFERENCES

- [1] E. Luke, E. Collins, E. Blades, A fast mesh deformation method using explicit interpolation, *Journal of Computational Physics* 231 (2) (2012) 586–601
- [2] Y. Mesri, H. Dignonnet, T. Coupez. Advanced parallel computing in material forming with CIMLib. *E. J. of Computational Mechanics*, 18(7-8):669-694, 2009.
- [3] Y. Mesri, J.-M. Gratien, O. Ricois, R. Gayno, Parallel Adaptive Mesh Refinement for Capturing Front Displacements: Application to Thermal EOR Processes, *SPE Reservoir Characterization and Simulation*, 2013.
- [4] Y. Mesri, H. Dignonnet, T. Coupez, Hierarchical adaptive multi-mesh partitioning algorithm on heterogeneous systems. *Parallel Computational Fluid Dynamics* 2008, 299-306
- [5] Y. Mesri, H. Dignonnet, H. Guillard, Mesh partitioning for parallel computational fluid dynamics applications on a grid, 631-642, *Finite Vol. for Complex App*, 2005
- [6] Y. Mesri. *Gestion et contrôle des maillages non structurés anisotropes: applications en aérodynamique*, PhD thesis, 2007
- [7] Y Mesri, W Zerguine, H Dignonnet, L Silva, T Coupez. Dynamic parallel adaption for three dimensional unstructured meshes: Application to interface tracking. *International Meshing Roundtable*, V. 17, pp. 195-212, 2008

- [8] L. Billon, Y. Mesri, E. Hachem, Anisotropic boundary layer mesh generation for immersed complex geometries, *Engineering with Computers*, 249-260, 2017