ON THE DYNAMIC LOAD BALANCING METHODS FOR IMMERSED-BOUNDARY APPROACHES

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Key words: Immersed Boundary, Wall modeling, Dynamic load balancing

Abstract. An immersed-boundary method (IBM) for simulation of thermal flow problems was implemented in our in-house code TermoFluids [1]. Which allow to simulate cojugate heat transfer problems, involving radiation interchange between moving and/or deforming bodies in static grids. These approaches impose the boundary condition reconstructing the solution in the vicinity of the body, which present two major drawbacks.

On the one hand, good wall-normal resolution is needed in the bodies near region, which requires refinement in all three directions, and this region can be arbitrarily large for moving bodies. In this work a boundary reconstruction based on wall layer modeling is employed in order to allow the use of non-refined grids near the object.

On the other hand, since the bodies are not uniformly distributed in space, the extra calculation needed for the boundary reconstruction can be concentrated in a small number of processors. To uniformly distribute this computational load in all processors, a dynamic load balancing method is used which minimizes the extra time of the IBM.

1 BOUNDARY RECONSTRUCTION

To calculate the velocity in the nodes in the vicinity of the bodies (P in figure 1) a boundary layer equation (1) is solved within a layer between the solid (R in figure 1) and the external LES solution (F in figure 1).

\[ \frac{\partial}{\partial y_N} (\nu + \nu_t) \frac{\partial u_i}{\partial y_N} = F_i, F_i = \frac{1}{\rho} \frac{\partial p}{\partial x_i} \]  

(1)

In order to appreciate the improvement of the solution a cross-flow around a cylinder with Re = 300 was simulated using both, the wall modeling approach and the linear reconstruction. Graphics on figure 1 shows that using the wall model a better agreement with the asymptotic solution of the wall shear stress is obtained, such as a more accurate estimation of the detachment of the boundary layer.
2 DYNAMIC LOAD BALANCING METHOD

A complex body falling in a box was used as test case to measure the benefits of apply the dynamic balancing method. The time used for the IBM calculations is reduced 8x when the computational load is balanced (figure 2), which signify a reduction of 60% in the total simulation time.

REFERENCES