Simulation of a Flow Using a Body-Fitted Coordinates System Modified from Cartesian Coordinates

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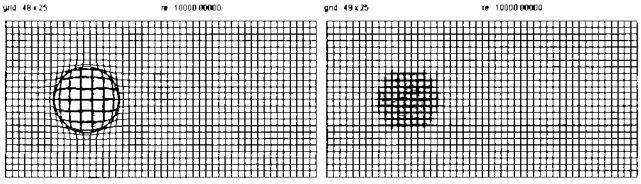
A flow past objects is simulated using a body-fitted coordinates system which is modified from Cartesian coordinates instead of using C or O-type coordinates. Using this coordinates system, the incompressible Navier-Stokes equations are solved by finite-difference approximation. Also multi-directional method with third-order upwinding are employed. Some kinds of flow are computed and the results show flow mechanisms clearly.

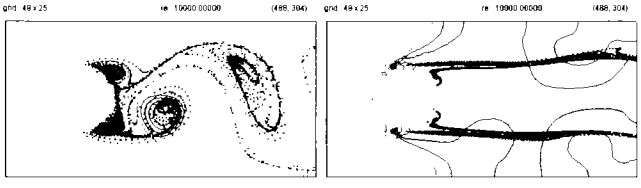
In this paper, the incompressible Navier-Stokes equations are solved by using the multi-directional finite-difference method with the third-order upwind method. The computation carried out using a body-fitted coordinates for saving grid points and capturing flow mechanism exactly. The general coordinates system in this computation is generated by modifying Cartesian coordinates, because it is easier to generate grids and to apply to other flow problems widely. Therefore, in this computation, no C or O-type grid is employed. As examples, flows around one or some bluff bodies are computed in two-dimensional domain in this paper.

Figure 1(a) shows body-fitted grid which is used for computation of a flow around a circular cylinder. On the other hand, in fig.1(b), the original grid of body-fitted one in Cartesian coordinates is displayed for the same computation. In both figures, circular shadow indicates a cylinder and the number of grid points is 49*25.



(a) Body-fitted coordinates. (b) Cartesian coordinates.
Figure 1. Computational grid.

In fig.2, (a) and (b) show results of 2-d computations of flow past a circular cylinder at Reynolds number = 10^4 using body-fitted and Cartesian coordinates respectively. In this figure, equi-pressure contour lines and particles from the surface of cylinder are expressed. Figures 3, 4 and 5 are other examples of computation using body-fitted coordinates system modified from Cartesian coordinates. These results show that flow mechanisms are well captured with the body-fitted coordinates even using coarse grid.



(a) Body-fitted coordinates. (b) Cartesian coordinates.
Figure 2. Pressure field and particles.

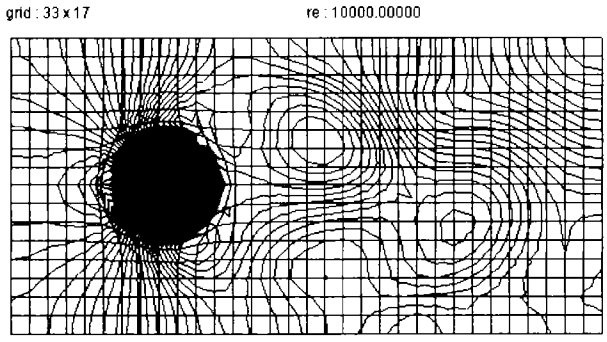


Figure 3. Equi-pressure contour lines. 32*16 grid points.

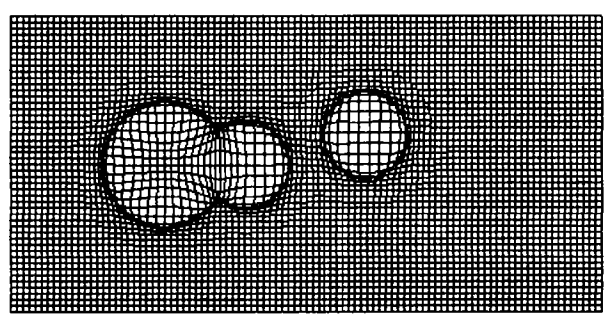


Figure 4. Computational grid for a flow past bluff bodies.

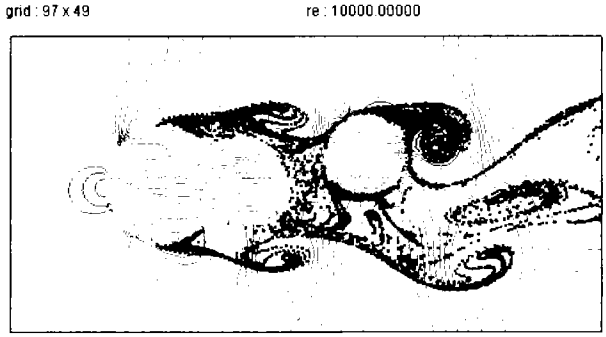


Figure 5. A flow past bluff bodies. Using grid in fig.4.

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