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IMMERSED BOUNDARY AND IMMERSED INTERFACE METHODS

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ABSTRACT

Computer simulations are becoming a primary tool for the design and analysis of complex systems. The continuous growth of computing power is encouraging engineers and designers to include high-fidelity computational fluid dynamics (CFD) in the design and testing tools of new technological products and processes. For flows of industrial interest, usually around and/or inside bodies of complex shapes, the generation of a high quality body-fitted grid can become extremely difficult and time-consuming, easily exceeding the time needed to obtain the flow solution. In addition, the resulting meshes are typically not guaranteed to be orthogonal, thus requiring more complex solution algorithms. This results in a significant overhead in the per–cell operation count and, therefore, increases the cost of the computation. Moreover, in some applications, the inherent motion of the boundaries creates an additional complexity. If one or more parts of the object are in relative motion, the solution procedure requires deformatting or regenerating the body–fitted grid, an extremely time consuming process. Therefore, a numerical procedure capable of handling complex geometric configurations without resorting to body–fitted meshes would allow a significant advance of CFD towards industrially relevant applications, especially in the initial design phase. The immersed boundary method (IBM) and the immersed interface method (IIM), using Cartesian grids, have emerged in the last few years as suitable candidates for achieving such a goal. In the IBM, the presence of a complex boundary is replaced by a time–spatially varying distribution of a forcing term which mimics the effect of the body on the flow. In the IIM, instead, the boundary is treated as a discontinuity and the difference scheme is modified locally, to maintain its spatial accuracy. The main advantage of these approaches is in the use of a Cartesian mesh, which allows very simple and efficient numerical techniques, for both incompressible and compressible flow simulations.

Therefore, it appears interesting and worthwhile to organize a minysimposium on immersed boundary and interface methods, so as to gather researchers who are developing and improving such methods, as well as those interested in industrial applications, such as moving bodies, fluid-structure interaction, film cooling and other complex heat-exchange pphenomena.