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NS-IBM: A PARALLEL INCOMPRESSIBLE NAVIER-STOKES SOLVER ON UNSTRUCTURED CARTESIAN MESH WITH AUTOMATIC MESH REFINEMENT

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A common feature of the various groups of the team "mécanique et environnement" of the Institute of Fluid Mechanics and Solid Strasbourg is the numerical modeling of various flows in complex geometries: turbulent flows, free surface flows, fluid-structure interaction, flows in airways. For this purpose, we use very different solvers, either free solvers or commercial solvers or solvers developed at IMFS developed. This raises, among others, the problem of continuity of knowledge.

Aware that a Navier-Stokes can not claim universality and potential to deal with any possible issues, we have developed a flexible and versatile tool for solving incompressible Navier-Stokes equations on Cartesian unstructured meshes. While the heart of a Navier-Stokes solver can be based on a relatively small selection of proven methods, the geometry processing for codes claiming geometric flexibility represents up to 90% of the investment in terms of development effort. The numerical method proposed is based on a finite volume conservative discretization and a unstructured and non-conforming grid designed to circumvent the problem of mesh generation by the use of automatic mesh refinement. The immersed boundary method is used handle the geometry.

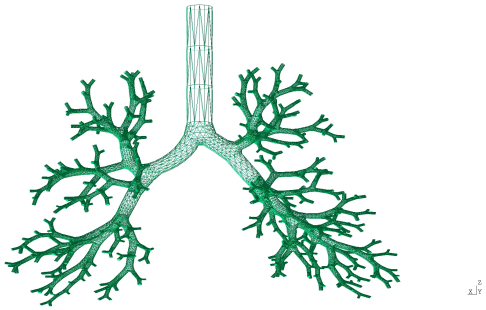

Figure 1Geometry of human airways

The solver is fully parallelized with MPI and so far it has been extensively validated on the test cases of the driven cavity, the cylinder and the square cylinder before it application on the simulation of flow in human airways. So far the AMR is only available as a pre-processing tool. In this conference we will present the concept of this solver, its validation and its application to the simulation of unsteady flows in a Human airways model under realistic breathing conditions.