An ALE residual distribution approach applied to the penalized Navier Stokes equations on adapted grids for moving solids

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In this work, we propose to study the coupling of unstructured mesh adaptation techniques with immersed boundary method (IBM) involving moving objects.

The starting point is an IBM known as penalization, introduced by Brinkmann in 1947 for a swarm of particles [1]. A source term is added to the usual Navier Stokes (NS) equations accounting for the boundary conditions.

A Strang Splitting approach [2] is employed to solve separately the NS part and the penalized part of the equations. It allows to remove the time step restriction known for penalization while using an explicit scheme, but conserving a global second order accuracy in time. In addition, forces computation can be performed using the method proposed on structured grids in [3]. Finally, this approach leads to a point by point resolution of the ordinary differential equation (ODE) ruling the penalized part, implying no matrix inversion.

To reduce the error on solid boundaries typically associated to IBM, an elasticity based adaptation technique is employed [4]. As this approach conserves mesh connectivity, the RDS are presented in an ALE framework. Those schemes are combined to an exact solution of the ODE governing the penalized part of the equations (over an asymptotic approximation with respect to the penalty parameter).

Results with fluid structure interactions leading to a solid motion will be presented to emphasize the interest of this work.

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