FIC STABILIZATION FOR PARTICLE METHODS IN FLUID MECHANICS PROBLEMS

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Computer simulation of the incompressible fluid flow equations using an space (Eulerian) formulation has been the classical way to analyze complex geometry and physics problems. However there are still difficulties to analyze problems in which the shape of the interface changes continuously or in fluid-structure interactions with free-surfaces where complicated contact problems should be considered.

More recently *Particle Methods* have been used in which each particle is followed in a material (Lagrangian) manner. The first ideas in this way were proposed by Monaghan for the treatment of astrophysical hydrodynamic problems with the method called *Smooth Particle Hydrodynamics* (SPH). This method was later generalized to fluid mechanic problems. Independently, a family of methods called *Meshless Methods* has been developed as well for structural as for fluid mechanics problems All these methods use the idea of a polynomial interpolant that fits a number of points minimizing the distance between the interpolated function and the value of the unknown point. These ideas were proposed first by Nayroles, used with structural mechanics by Belytschko and with fluid mechanics problems by Oñate [1].

More recently [2], the meshless ideas were generalized to the Finite Element Method in order to obtain the same computing time in mesh generation than in meshless connectivity. This method was called the Meshless Finite Element Method (MFEM) and uses a polyhedrization to build the mesh in a computing time which is linear with the number of particles [3].

In the Eulerian form of the momentum equations, the discrete form must be stabilized in order to avoid numerical wiggles in the velocity results. This is not the case in this Lagrangian formulation where none stabilization parameter must be added in the momentum equations. Nevertheless, for incompressible flows, the mass conservation must be stabilized in equal-order approximations to avoid possible pressure oscillation.

The *finite calculus* (FIC) formulation will be chosen here as the stabilization procedure. This formulation is based in the modification of the governing differential equations of the problem by accepting that the domain where the balance laws are established (balance of momentum and balance of mass) has a finite size The Finite Calculus formulation shows to be also successfully in eliminate the spurious pressure oscillations in a Particle Method.

References

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