On some drawbacks and possible improvements of a Lagrangian finite elements approach for simulating incompressible flows

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ABSTRACT

In the spirit of the so-called Particle Finite Element Method (PFEM)[1,2,3], a mixed velocity-pressure finite element formulation to solve the Lagrangian form of the incompressible Navier-Stokes equations for Newtonian fluids is presented, using a monolithic approach in combination with a pressure-stabilizing Petrov-Galerkin technique, as discussed in [4].

The key idea of the method is a continuous and fast re-triangulation of the domain to take into account the large deformations induced by the fluid motion. Here some problems arising from the use of such a method, especially when no extra care is taken in transferring the data from one mesh to another, are highlighted.

In particular it is shown how an abrupt change in nodal connectivity can lead to the introduction of non-negligible perturbations in the solution. As a consequence, the possibility of using a nodal-based integration scheme, over the classical Gaussian integration, for the solution of the weak form is investigated.

Some results and comparisons against available benchmarks in literature are presented.

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