Particle Methods in Coupled Problems

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ABSTRACT

One of the main drawbacks of all the time integration algorithms using an Eulerian formulations in Coupled Problems is the restricted time-step to be used to have acceptable results.

For the case of fluid-structure interactions (FSI) with or without free-surfaces or for the case of fluid with moving internal interfaces (multi-fluids), it is well known that in the explicit integrations, the time-step to be used in the solution is stable only for time-step smaller than two critical values: the Courant-Friedrichs-Lewy (CFL) number and the Fourier number. The first one is concerning with the convective terms and the second one with the diffusive ones. Both numbers must be less than one to have stable algorithms. For convection dominant problems the condition CFL<1 becomes crucial and limit the use of explicit methods or outdistance its to be efficient. On the other hand, implicit integrations using Eulerian formulations are restricted in the time-step size due to the lack of convergence of the non-linear terms. Both time integrations, explicit or implicit are, in most cases, limited to CFL no much larger than one [1].

In this lecture we will present a Particle Method to solve coupled problems like FSI or multi-fluid problems that use in all the domain (solid and fluid) a Lagrangian formulation with explicit or implicit time integration without the CFL<1 restriction. This allows large time-steps, independent of the spatial discretization, having equal or better precision that an Eulerian integration [2].

The proposal will be tested numerically for FSI and multi-fluid flows problems using the Particle Finite Element Method second generation (PFEM2). The results show than this Particle Method is largely more efficient compared as well in accuracy as in computing time with other more standard Eulerian formulations [3].

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