Embedded Techniques for FSI Problems

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ABSTRACT

The maturity of numerical techniques both in Structural Mechanics and in Computational Fluid Dynamics (CFD), accompanied by the availability of affordable high-performance hardware, allows the use of virtual rapid-prototyping facilities (for example virtual wind tunnels) as realistic alternatives to traditional wind tunnel experiments.

This work aims to present the strategy developed by the authors for the creation of a virtual wind tunnel (VWT) especially designed for the analysis of lightweight structures. An embedded approach in the context of Variational Multi Scale (VMS) techniques is proposed to face FSI problems involving the movement of arbitrary objects within a fixed fluid domain. This method is based on an efficient intersection procedure which allows detecting how a given surface mesh, representing the shape of the object of interest, “cuts” the fixed fluid mesh. On the basis of such information, the underlying finite element formulation is modified at purely local level so to embed a discontinuity into the finite element space. The method is completed by a technique to weakly impose slip (or wall) boundary conditions on the cut interfaces.

A distinctive feature of the proposed method is to allow the simulation of membrane structures, typically challenging for embedded solvers due to the need of modelling a strong discontinuity of the flow field in correspondence of the structural position.

The method is evaluated in application to real deformable structures for which experimental results are available.

All the presented strategies are developed inside Kratos Multiphysics open source platform (http://www.cimne.com/kratos/).