Staggered strong coupling between existing fluid and solid solvers through a Python interface for Fluid-Structure Interaction problems

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ABSTRACT

In this work, a modular and flexible coupling tool for the study of Fluid-Structure Interaction (FSI) problems will be presented. The FSI tool has been designed to couple existing and independent fluid and solid solvers into a single synchronization and communication framework based on the Python language. Each solver has to be wrapped in a Python layer in order to embed their functionalities (usually written in an other language) into a Python object, that is called and used by the coupler. Thus a staggered strong coupling can be achieved for time-dependent FSI problems such as aeroelastic flutter or vortex-induced vibrations (VIV). The synchronization between the solvers is performed with the Block Gauss-Seidel algorithm with a dynamic under-relaxation. Moreover, the tool allows non-matching meshes between the fluid and structure domains. It is optimised to work in parallel with Message Passive Interface (MPI). These capabilities will be demonstrated on typical validation 2D and 3D cases including a flat plate wing with pitch and plunge degrees of freedom [1], the Isogai Wing Section [2], the VIV of a flexible cantilever in the wake of a square cylinder [3] and finally the AGARD 445.6 wing [4]. The open-source code SU2 [5] is used to compute the fluid region. The solid region is computed either by a simple rigid body integrator or by an in-house nonlinear Finite Element code (Metafor) [6]. First the accuracy of the results will be demonstrated and then the modularity of the coupling as well as its ease of use will be highlighted.

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