Abstract:
Many popular partitioned approaches to fluid-structure interaction (FSI) problems fail to work for an interesting subset of problems if highly deformable structures are interacting with incompressible flows. This is particularly true for coupling approaches based on Dirichlet-Neumann substructuring, both for weak and strong coupling schemes. The subset is characterized by the absence of any unconstrained outflow boundary at the fluid field, that is the fluid domain is entirely enclosed by Dirichlet boundary conditions. The inflating of a balloon with prescribed in flow rate constitutes a simple problem of that kind. The commonly used coupling algorithms will not satisfy the fluid's incompressibility during the FSI iterations in such cases. That is because the structure part determines the interface displacements and the structural solver does not know about the constraint on the fluid field. To overcome this deficiency of partitioned algorithms a small augmentation is proposed that...
consists in introducing the fluid volume constraint on the structural system of equations. This allows to circumvent the dilemma of the fluid's incompressibility. At the same time the use of a Lagrangian multiplier to introduce the volume constraint allows to obtain the pressure level of the fluid domain. However, the customary applied relaxation of the interface displacements has to be abandoned in favor of the relaxation of coupling forces. These modifications applied to a particular strong coupled Dirichlet-Neumann partitioning scheme result in an efficient and robust approach that exhibits only little additional numerical effort. Numerical examples with largely changing volumes of the enclosed uid show the capabilities of the proposed scheme.

Stichworte:
Fluid-structure interaction, pure Dirichlet domain, incompressible fluid, augmented Dirichlet-Neumann approach

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