Modeling Coupled FSI Systems Undergoing Changes in Topological Properties

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ABSTRACT:

A key component of modeling the interaction between flexible structures that either surround a region of fluid (as with blood flow through arteries) or are immersed within an ambient fluid (such as canopies used for parachutes) is the simulation of the behavior of the system whenever structural components are in intermittent contact or very close to a contact configuration. In such situations, the topological properties of the computational fluid domain change. Thus, a modification of the assumptions within the dynamic fluid model is required. The ability to include collapse and expansion of the flexible structure and thereby create and destroy gaps and pockets within the fluid domain will enhance the ability to predict regions of extreme stress and frequent failure in the elastic structure. Moreover, an accurate representation of the boundaries between the fluid and solid allows for an effective analysis of boundary layers and flow separation within a computational fluid dynamics environment. This research focuses on the design and implementation of new computational fluid-structure interaction algorithms that automatically update the topological configuration of the system in order to drive adaptive grid movement and dynamic modification of the physical properties within each sub-domain. The resulting discrete formulations will be used to mimic the opening and closing of thin elastic structures in the presence of viscous fluid flow.

KEYWORDS: fluid-structure interaction, computational fluid dynamics, intermittent contact

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