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SPACE–TIME INTERFACE TRACKING IN FLUID MECHANICS COMPUTATIONS WITH CONTACT BETWEEN MOVING SOLID SURFACES

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We present a space–time (ST) interface-tracking (moving-mesh) method [1] that gives us interface-tracking accuracy in fluid mechanics computations with contact between moving solid surfaces or other topology change (TC). The method is a new version of the Deforming-Spatial-Domain/Stabilized ST (DSD/SST) method [2-6], and we call it ST-TC. With this method, fluid mechanics computations, even in the presence of contact between the moving solid surfaces, can be done without compromising accurate representation of the flow patterns near the fluid–solid interfaces. This enables us to accurately model challenging problems such as heart valves with contact when the valve leaflets close. The method includes a master–slave system that maintains the connectivity of the "parent" mesh when there is contact between the moving interfaces. It is an efficient, practical alternative to using unstructured ST meshes. We explain the method with conceptual examples [1], present 2D test computations [1] with models representative of the classes of problems we are targeting, and 3D computations with heart valve models [7]. We present computations for two models: an aortic valve with coronary arteries (Figure 1) and a mechanical aortic valve (Figure 2). These computations demonstrate that the ST-TC method can bring interface-tracking accuracy to fluid mechanics problems with TC, and can do that with computational practicality.

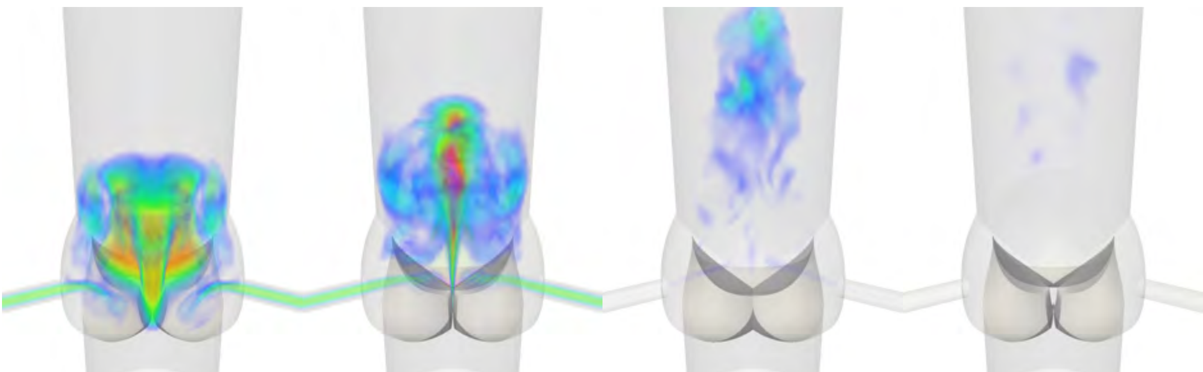

Figure 1. Aortic valve with coronary arteries. Velocity magnitude at t/T = 0.4, 0.5, 0.6, 0.7.

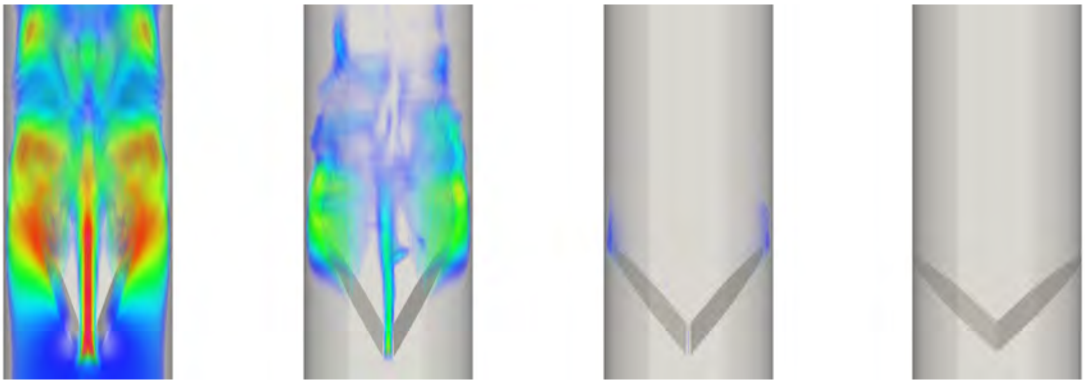

Figure 2. Mechanical aortic valve. Velocity magnitude at $t/T = 0.2, 0.3, 0.4, 0.5$.

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