High-Performance Computing for Incompressible Flow and FSI with Emphasis on Patient-Specific Cardiovascular Modeling

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ABSTRACT

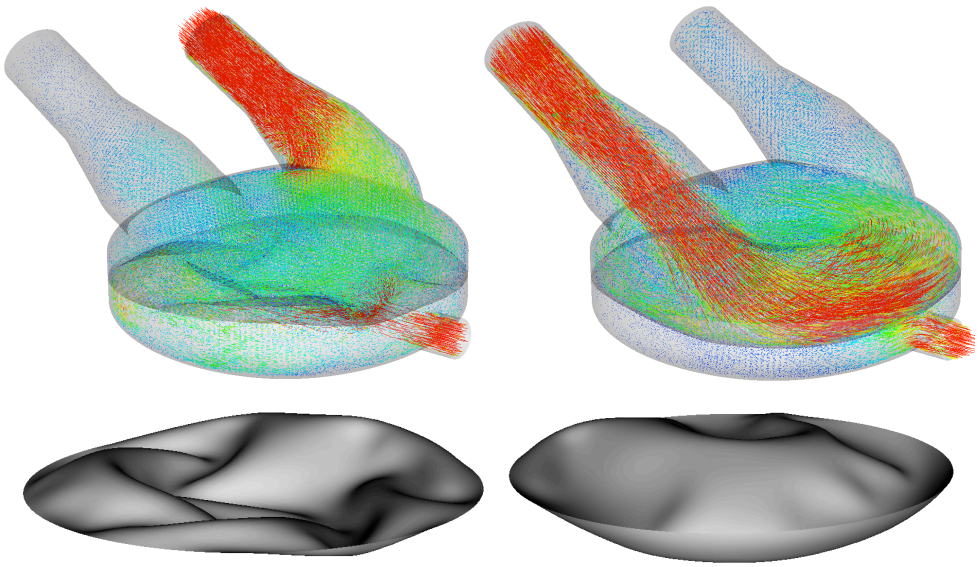

Figure 1. FSI simulation of a pulsative ventricular assist device.

The first part, the presentation is focused on high-performance computing (HPC) aspects of simulations involving incompressible flow. A new solution strategy for the linear equation system arising in the discretization the Navier—Stokes equations of incompressible flow using a mutiscale method is presented. The proposed approach leads to an efficient solution algorithm that outperforms conventional techniques. Further improvements in parallel scalability of the solver due to the use of novel data structures are also presented. In the second part, a framework for computational fluid-structure interaction (FSI) based on the Arbitrary Lagrangian—Eulerian formulation is presented [1]. Basics of Isogeometric Analysis [2] are also discussed. FSI coupling strategies and their implementation in the high-performance parallel computing environment are also discussed, and computational challenges presented. Simulations from cardiovascular fluid mechanics and FSI, as well as other applications, are presented (see Figure 1).

REFERENCES

[1] Y. Bazilevs, K. Takizawa, and T. E. Tezduyar. *Computational Fluid–Structure Interaction: Methods and Applications.* Wiley, 2013.

[2] J.A. Cottrell, T.J.R. Hughes, and Y. Bazilevs. *Isogeometric Analysis: Toward Integration of CAD and FEA.* Wiley, 2009.