Institute of Biomedical Engineering (IBT)
Computational Cardiac Modeling Group

Lattice Boltzmann Research Group (LBRG)

Flow-based Estimation of Cardiac Motion Using Lattice Boltzmann Methods

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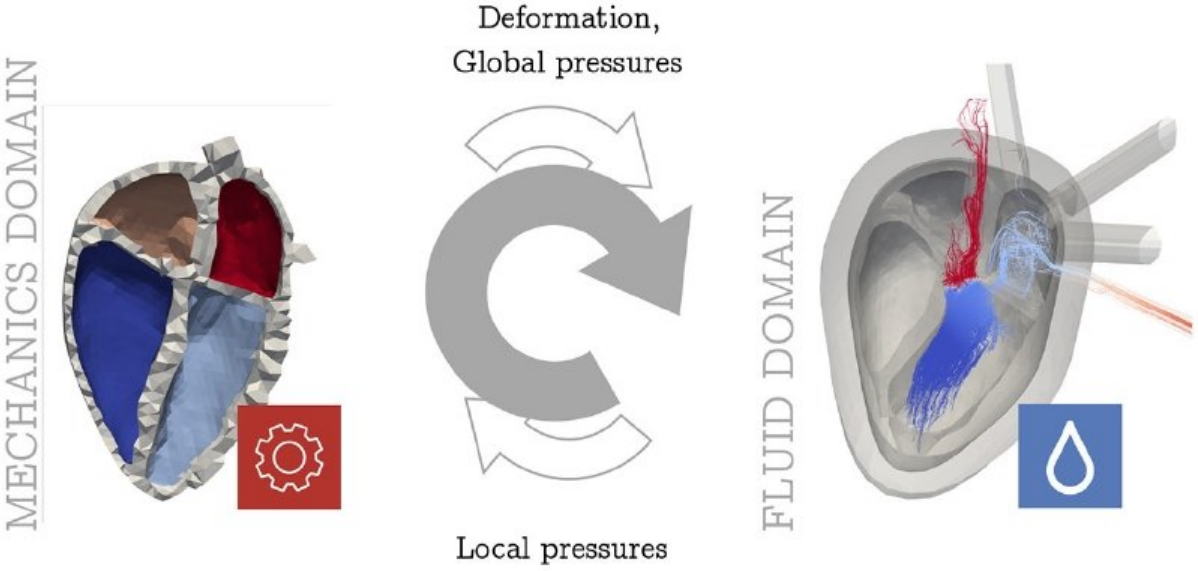
Motivation and Background

Computational modeling and simulation is a promising approach to tackle cardiovascular diseases, which remain a major reason for morbidity and mortality around the world. The pumping of blood is driven by the mechanical contraction of the heart. Both processes can be modeled (continuum solid mechanics and fluid mechanics, Brenneisen et al. 2021 https://dx.doi.org/10.3389/fcvm.2021.768548) but their interplay is complex. Taking also comprehensive patient-specific measurements into account for the simulations is a great challenge. For example, solving parameter identification through inverse problem formulations (Kovacheva et al. 2021 https://dx.doi.org/10.1002/cnm.3448) incurs high computational costs in classic Finite Element Method (FEM) settings. Lattice Boltzmann Methods (LBM) are computationally efficient and were successfully used to identify static fluid domain boundaries (Klemens et al. 2018 https://doi.org/10.1016/j.compfluid.2018.02.022). Their further development and application are the overall goals of this project.



Student Project

This Master thesis project shall extend the LBM-based approach to moving domains as occurring in the human heart. The objective is to compute the time course of the position of the heart wall during the cardiac cycle compatible with the Navier Stokes equation for a given intracardiac blood flow fields. For this, the student will be integrated in the Cardiac Modeling Group at IBT (FEM continuum cardiac mechanics expertise) and the Lattice Boltzmann Research Group at IANM/MVM (LBM expertise). The details of the project can be tailored to your expertise and goals.

If you are interested or have questions, send an email!