

HiWi position

Software Engineering for Numerical Solver Integration in the openCARP Cardiac Electrophysiology Simulator

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Motivation and Background

Cardiac muscle cells generate electrical currents to coordinate action internally and to communicate with their neighbors so that the 2 billion cells that make up the heart muscle can work as a unit. Numerical modeling is vital to understand this system, and, thereby, to design effective drugs and interventions. Nowadays, it is possible to couple millions of cellular models to simulate the activity of the whole heart. Such models can accurately predict the whole-organ effects of changes on the cellular level, and play an important role in research on cardiac pathologies, diagnostic methods, and the prediction of treatment results. However, because present models use a spatial scale several times larger than the cell size, they provide only crude approximations of the events in aging or structurally diseased hearts. Realistic simulations of cardiac electrophysiology in structurally abnormal tissue require discretization of the individual cells and their interconnections. This means at least a factor 10^4 increase in model size compared to what researchers currently run on tier-1 supercomputers, as well as a different model formulation. For such simulations, not only exascale supercomputers are needed, but also a joint effort of biomedical engineers, mathematicians, and computer scientists. The purpose of the openCARP-XL project is to explore and pioneer the idea of a production-ready simulation platform for cardiac electrophysiology on models with micrometer resolution.

Scope and Goal of the HiWi Project

In the openCARP-XL project, we will complement the existing macroscopic openCARP simulation platform (www.openCARP.org) with the Ginkgo high performance linear algebra technology (github.com/ginkgo-project/ginkgo). Even though openCARP-XL will not accomplish the simulation of billion cell models, it will explore the design space in terms of problem-tailored numerics for upscaling. As a first step, the openCARP-XL project will establish a common language and interface between the cardiac electrophysiology simulator openCARP and the Ginkgo high-performance numerical software. This is a joint project of the Cardiac Modeling Group at IBT (Campus South) and the FiNE Group at SCC (Campus North). You'll work with both groups at both places.

Your profile:

- Experience in C++ software development (coding, compilation, design)
- Interest in cardiac electrophysiology simulations
- Interest in numerical linear algebra
- Strong communicator with good command of English
- Ability to work independently
- Reliability

Two positions with 35-42 hours per month are open from now on. Apply by email with a short motivation letter and your CV