University of Stuttgart
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SimTech

ISD

Announcement – Master's Thesis

Coupling of macro and micro scale in a continuum-biomechanical model of the human liver using preCICE

Motivation: To describe the complex function-perfusion relationship in the human liver, the hepatic tissue scale is described by partial differential equations (PDEs) in a homogenization approach based on the Theory of Porous Media (TPM). These equations are coupled with ordinary differential equations (ODEs), representing the metabolic processes in the liver cells. While the PDEs on the tissue scale are solved by the FEM-solver FEBio, the ODEs on the cell scale are solved by the biochemical software library libRoadRunner. For an efficient and smart coupling of the two solvers, the functionality of the preCICE coupling library can be used. preCICE is an open-source coupling library for partitioned multi-physics simulations [1]. The thesis will be a joint collaborative work between the groups of Tim Ricken, ISD and Benjamin Uekermann, IPVS.

Goal: Implementation of an adapter component to facilitate coupling of FeBio using preCICE and calling multiple instances of libRoadRunner. Once both modifications are done, the coupling is done using an existing Micro Manager. Develop a working coupling model using preCICE and reproduce results from models coupled in a different way.

Tasks: Familiarity to preCICE functionality will be acquired by running tutorial cases using existing adapters (OpenFOAM, FEniCS). Subsequently, the adapter for FEBio will be implemented and validated. The coupling is then to be tested and evaluated in a proof-of-concept. In addition, different coupling functionalites can be added to the software.

Requirements: Ideally you have first experience with numerical simulations and the Finite Element Method, as well as first programming experience (C++, Python).

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[1] https://precice.org/