Institut für Baumechanik
und Numerische Mechanik

Gottfried Wilhelm Leibniz Universität Hannover
IBNM, Appelstr. 9a, 30167 Hannover

Leibniz Universität Hannover

Prof. Dr.-Ing. D. Schillinger

www.ibnm.uni-hannover.de

edited by:
M.Sc. Adnan Ebrahem

Tel.: +49 (0)511.762-**5085**
Room: 3408 - **113**
E-Mail: **adnan.ebrahem**
@ibnm.uni-hannover.de

Master thesis

Thesis received: XX.XX.20XX	Workload: 720 h (24 CP)
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First examiner: Prof. Dr.-Ing. D. Schillinger	Supervisor: M.Sc. Adnan Ebrahem
Second examiner: Prof. Dr.-Ing. U. Nackenhorst	

Algorithmic implementation of a hepatic vascular tree generation for modeling blood perfusion in the liver
Implementierung einer Gefäßstruktur zur Modellierung der Blutperfusion in der Leber

The key connection between the liver and the rest of the human body is the blood flow through the vascular system. The blood flow is essential for several metabolic processes. Thus, for a surgeon the vascular network in the liver plays a major role in defining the operative strategy and estimating the postoperative success. Accordingly, the algorithmic generation of vascular tree systems and biomechanical modeling of blood flow have become powerful tools that can be taken into account for a patient-specific planning. The most popular approach is the so-called Constrained Constructive Optimization (CCO) [1,2]. The basic principle of CCO is to grow the model tree by adding successively new segments, which is based on optimization principles without direct input of anatomical data.

One main part of this work will be a literature review on numerical approaches that can be used to generate a hepatic vascular tree system. The focus of this thesis should be laid on the implementation of simple numerical models at different scales, possibly using some model reduction by considering different hierarchies. Finally, the implemented algorithm should be applied to model blood flow in the liver.

Requirements:

- Knowledge about Continuum Mechanics
- Knowledge about Programming
- Course on FEM and CFD

Objectives:

- Obtaining fundamental understanding about hepatic vascular tree generation
- Implementation of a numerical method for the generation of a vascular network in the liver
- Numerical simulation of liver perfusion

Literature:

[1] SCHREINER, WOLFGANG, & PETER FRANZ BUXBAUM (1993): "Computer-optimization of vascular trees." IEEE Transactions on Biomedical Engineering 40.5, 482-491.

[2] SCHWEN, LARS OLE, & TOBIAS PREUSSER (2012): "Analysis and algorithmic generation of hepatic vascular systems." International journal of hepatology.