Constitutive modeling of liver regeneration

TECHNISCHE UNIVERSITÄT DARMSTADT

Bachelor's or Master's thesis (CE, mechanics, mechanical engineering, civil engineering, mathematics)
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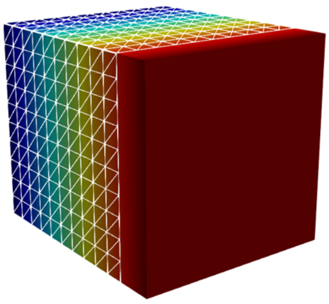
Scope of Work

The liver has high regenerative properties. In practice, this existing knowledge is already used by performing liver resections in which up to 3/4 of the liver can be removed, for example in case when a tumor is found in a liver lobe. The regrowth of the liver after resection itself is a process occuring over many scales which requires input and output values between different scales. A result of segmental resection is hyperperfusion as the same amount of blood is passing a smaller remaining liver that leads to higher blood velocity and thus higher shear stresses in the sinusoidal capillaries. The shear stress in these microvessels is essential for triggering the growth of the liver.
One main part of this work will be a literature review on the multiscale regrowth process of the liver (mechanical, biochemical and physiological factors). A particular focus lies in connecting the microscale shear stresses with growth parameters of the macroscale growth model. The macroscale growth model can be implemented within the framework of the so-called finite growth theory that has been heavily studied for other applications (cardiac wall thickening, cardiac dilation, artery growth). An implemented version of the growth model is already existing and further studies can be build up based on this code. Basic continuum mechanics and FEM knowledge is sufficient to understand and implement constitutive evolution equations on a simple benchmark which will be the main part of this work. The thesis can be done in German or English.



Tasks

- Obtaining fundamental understanding about the multiscale regrowth process of the liver (mechanical, biochemical and physiological factors)
- Obtaining knowledge on material modeling for a biomechanical application
- Implementing growth evolution equations on a simple geometry e.g. on a cube

Prerequisites

- Knowledge about Continuum Mechanics and FEM
- Knowledge about Programming

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