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Interdisciplinary project - *Interdisziplinäres Projekt*

for

Vorname Nachname

Student No.: XXXXXXXX

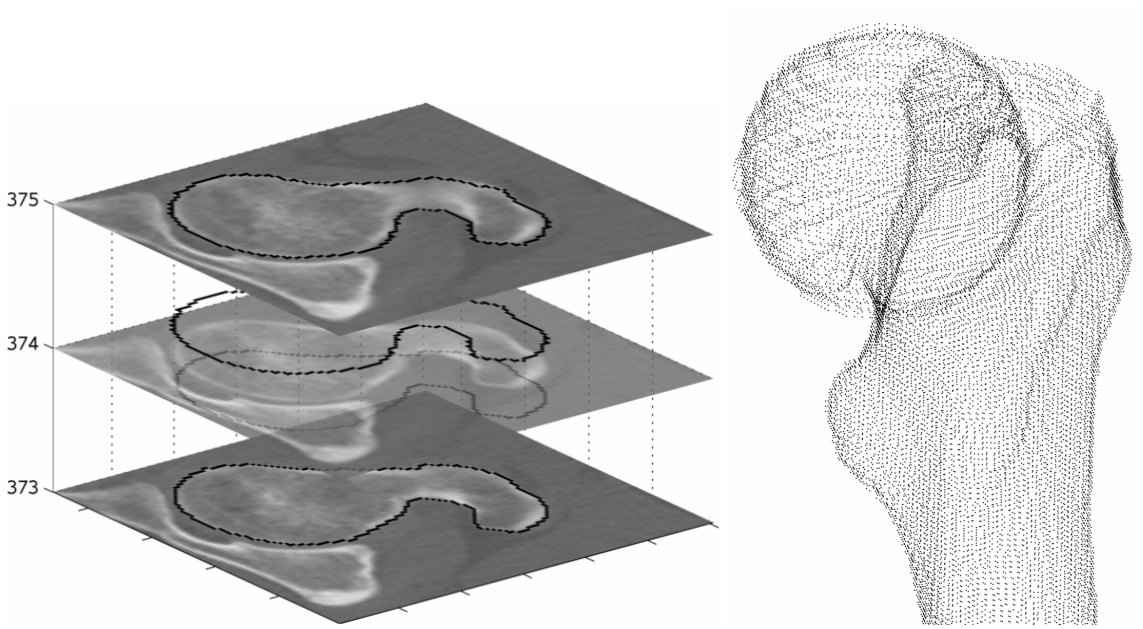
Thesis received: XX.XX.2022	Workload: 360 h (12 CP)
Submission of thesis until: XX.XX.2022	Duration: 6 months
Examiner: Prof. Dr.-Ing. U. Nackenhorst	Supervisor: Fynn Bensel, Marlis Reiber

Neural Network guided Finite-Element Model Creation from Medical Image Data

Erstellung von Finite-Element Modellen aus medizinischen Bilddaten mit Hilfe Neuronaler Netze

The need for computational expertise in the medical sector is increasing. Especially, in the field of orthopedics a lot of surgeries are planned purely based on geometrical and empirical assessment. Phenomenological models can be used to gain information with respect to the mechanical behavior. The generation of accurate Finite Element models from medical image data is important to enable patient specific simulations. This procedure has been of interest in recent research and first promising results have been published. The application of Convolutional Neural Networks proved itself beneficial, in particular for the bone segmentation.

The aim of this work is to fully automatize the generation of finite element models from medical image data. In the scope of this work, FE models of the femur bone from CT data are the main focus. An own framework shall be implemented, taking latest findings of the research into account.



Literature:

[1] A. LUTZ (2011): Ein Integrales Modellierungskonzept zur Numerischen Simulation der Osseointegration und Langzeitstabilität von Endoprothesen. *PhD Thesis, Institute for Mechanics and Numerical Mechanics, Leibniz University Hanover*, 2011.

[2] R. CAMPANINI (2017): A Deep Learning Approach to Bone Segmentation in CT Scans. *Master Thesis, Institute for Physics and Astronomy, University of Bologna*, 2017.

Prerequisites:

- Fundamental knowledge about the Finite Element Method
- Basic knowledge and interest in programming
- Basic knowledge about Computer Vision & Convolutional Neuronal Networks (*favorable*)
- Basic knowledge of the **julia** programming language (*favorable*)
- Basic knowledge of commercial FE software (e.g. Abaqus, ANSYS) (*favorable*)

Workload:

1. Preparing a milestone plan for a regular discussion of progress with the supervisor. The milestone plan needs to be handed in one week after receiving the task description. In case of circumstances, the milestone plan needs to be updated as agreed upon the supervisor.
2. Literature review on model generation from CT data, Computer Vision, Convolutional Neural Networks
3. State-of-the-Art review of existing methods
4. Evaluation / comparison / discussion of the different methods / algorithms
5. Implementation of own framework in **julia**
6. Validation of implemented methods
7. Documenting all steps and results regarding established scientific standards.
8. Self-evaluation of the student's own work using the attached evaluation matrix.
9. Presenting (15 to 20 minutes) the thesis within a colloquium.

In addition to an abstract in English and in German, five content describing key words have to be stated. The written report is to be submitted in one printed version. Additionally, all data are to be attached digitally.