Final Thesis

Using super-resolution networks to generate highly resolved computed tomography images from recordings with low resolutions

Methods to diagnose pathologies in the human respiratory system have recently evolved to include results of computational fluid dynamics (CFD) simulations. CFD methods allow to numerically qualify the nasal cavity by analyzing fluid mechanical properties of respiratory flows, e.g., the pressure loss, the temperature distribution, or the the mass flux distribution. However, the preparation for numerical analyses requires time-intensive manual interactions such as the extraction of the nasal cavity surface from computer tomography (CT) recordings or the subdivision of the surface into different types of boundaries. To accurately predict the flow in the nasal cavity by means of numerical simulations, highly resolved computational meshes are necessary. The corresponding time-consuming simulations require high-performance computing (HPC) systems. Machine learning (ML) techniques have the potential to automatize and accelerate such computations.

In order to use ML approaches, a large number of highly resolved CT recordings is required. However, such recordings entail radiation doses leading to a risk for the patient's health. CT recordings which expose the patient to less radiations are therefore frequently used in clinical environments. The low radition dose also leads to a low resolution of the CT recordings, which renders them useless for CFD simulations.

In this study, the student investigates the potential of ML algorithms for generating highly resolved images from recordings with low resolutions. Training data can be processed from an existing database of CT recordings with different resolutions. Generated images are then validated by comparing the results of CFD simulations using the ML-generated images and the original highly resolved CT recordings. The simulations make use of a a highly scalable lattice-Boltzmann method.

Specific tasks of this theses are:

- extraction of data from a CT database and preparation of the training data
- development of architectures of super-resolution networks
- training and testing the super-resolution networks
- validation of the developed methods by comparing simulation results using network-generated and original CT images

If you are a student in Mechanical Engineering, CES, or Simulation Sciences and would like to write your final thesis about the topic presented above, feel free to contact me.

Contact person: Andreas Henze
Tel.: +49 241 80 94 894
Email: a.henze@aia.rwth-aachen.de