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Bachelor's Thesis

Development of a Mouse Vascular Network Model for the Simulation of Medical Research Scenarios

Abstract

Modern medicine increasingly aims to reduce the amount of animal testing in research. One approach is to use computer simulations to reduce the amount of necessary real-world experiments. In this case, in silico animal models can be employed as a substitute for physical animal models.

MEHLISSA [1], [2] is a simulation tool for in-body communication and disease modelling in the human circulatory system. To use this simulator in research and efficiently simulate medical research scenarios in silico, we need a model of the circulatory system of a mouse in addition to the existing human model.

In this thesis, you will create such a model and evaluate its suitability for simulations.

Content

The goal of this thesis is to develop a model of the circulatory system of mice and to evaluate its accuracy in MEHLISSA for represent medical research scenarios. The code generated in this thesis will contribute to the open source gitHub project for MEHLISSA https://github.com/RegineWendt/MEHLISSA/tree/main/mehlissa2.0

Requirements

Good practical skills in C++ and interest in physics and biology are a requirement.

Previous work with particle simulators and programming basics in MATLAB are helpful.

You will not work with physical mouse models in the thesis and you do not need special knowledge in medicine or biology to start this thesis.

[1] L. Y. Debus, R. Wendt, S. Fischer, and F. Dressler, "MEHLISSA 2.0: Accelerating Full-body Molecular Communication Simulations," in 12th ACM International Conference on Nanoscale Computing and Communication (NANOCOM 2025), Poster Session, Chengdu, China: ACM, Oct. 2025, pp. 171–172. DOI: 10.1145/3760544.376564.

[2] S. Pal et al., "Machine Learning-Driven Localization of Infection Sources in the Human Cardiovascular System," IEEE Transactions on Molecular, Biological and Multi-Scale Communications, vol. 11, no. 4, pp. 524–530, Dec. 2025. DOI: 10.1109/TMBMC.2025.3605770.

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