



Automated 3D mesh preparation and parameter determination for SPH simulations

Project Management and Software Development
for Medical Applications

General Info



Virtonomy.io

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Project Abstract

In this project, the student will work on a Python library to simplify and accelerate the transition from 3D meshes of the cardiac region to patient-specific simulations (using smoothed particle hydrodynamics (SPH) simulations). Specifically, the project will focus on ensuring mesh quality, determining additional parameters needed for particle generation for simulations, and modifying meshes for developmental purposes.

Background and Motivation

Virtonomy GmbH is developing the first web platform for conducting fully data driven clinical trials of medical devices with the use of virtual patients. Our system is based on clinical scans (CT, MRI), pathological data and data about medical devices. The reconstruction of 3D anatomy models from image data and the subsequent simulation of clinical devices on these 3D models are the most important parts of the overall pipeline. Since the preparation of 3D models (in our case STL files) for simulations still involves manual steps, further automation is needed to perform patient-specific simulations even faster.

Student's Tasks Description

- Working on an existing repository for mesh quality assurance.
- Develop strategies to improve identified mesh issues while preserving anatomical accuracy.
- Extension of this code base with functions for parameter determination for SPH simulations, e.g., wall thickness for particle size determination.
- Creation of development models that can be used at low resolution, e.g., by thickening thin walls.

In the end, the code should meet high quality standards, i.e., it should be documented, linted and provided with test functions so that it can be integrated into the productive code of Virtonomy. These tasks help the student to professionalize their programming skills and expand aspects that are often neglected in the academic environment.

Technical Prerequisites

- Strong skills in python
- Experience and good understanding with GIT
- Experience in mesh handling libraries like trimesh or pyvista
- Experience with 3D medical image segmentation and SPH simulations is useful but not required.

References

- <https://github.com/mikedh/trimesh>
- Zhang et al. (2021): "SPHinXsys: An open-source multi-physics and multi-resolution library based on smoothed particle hydrodynamics"