Chair of Computational Modeling and Simulation
TUM Department of Civil, Geo and Environmental Engineering
Technical University of Munich

Software Lab:

Optimization Framework for the Development of Implantable Medical Devices

Modeling:
Mathematics:
Programming:
Science:

Description

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), pathology data, and data about medical devices. Medical device simulation is one of the key features of our offering. Our web platform provides a device and use case-tailored simulation models for medical device developers to investigate dynamic tissue-device interaction.

This project aims at implementing an optimization framework that allows finding ideal device positions (Total Artificial Heart), ideal device path in vessels (Catheter/Endoscope) concerning minimal tissue strain, and enables the calibration of soft tissue material models (parameter optimization). The simulation framework is based on the mesh-free Smoothed Particle Hydrodynamics (SPH) method, implemented in C++. The optimization use cases will be directly available on our web platform for medical device developers.

Figure 1.: Simulation of Total Artificial Heart to evaluate device fit

Task

Implement an optimization framework that uses results from current simulation models to reach specific targets and find ideal input parameters:

- Get to know the SPH software and the current use cases (Total Artificial Heart, Catheter/Endoscope, Material Tests)
- Research and define optimization methods that are appropriate for the above use cases: response surface-based, evolutionary algorithms, deep learning-based, etc.
- Expand the current software architecture to be able to perform optimization tasks, especially focusing on the Python – C++ interface
- Implement the optimization methods (Python), compare, benchmark, and select the most efficient one for each use case

Supervisor

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References

https://www.sphinxsys.org/