



Deformation of soft tissue using physics-based simulator

Project Management and Software Development
for Medical Applications

General Info

Contact Person: Yordanka Velikova

Contact Email: dani.velikova@tum.de

Project Abstract

Soft tissues, such as organs and muscles, are highly deformable and their behavior can change significantly during surgical procedures, making it essential to account for this deformation change. The power to accurately predict and simulate soft tissue deformation using physics-based simulators is a stepping stone for improving the safety, efficacy, and precision of image-guided interventions. This project's main objective is to explore the capabilities of the SOFA (Simulation Open Framework Architecture) software framework for modeling soft tissue deformation in surgical procedures.

Background and Motivation

In image-guided procedures, the ability to precisely predict and simulate tissue deformation is crucial for successful outcomes. Here, the smallest change in the shape or position of soft organs or tissues can significantly influence the planning of surgical incisions, placements of intraoperative devices, and precise targeting of selected structures [1].

Physics-based simulators can provide physicians with a valuable tool to plan and execute surgical interventions, as they can accurately simulate soft tissue deformations during medical procedures. These simulators are capable of simulating how soft tissue deforms under the influence of external forces.

Driven by these challenges, this project will focus on SOFA (Simulation Open Framework Architecture), an open-source software framework designed for the development and implementation of physics-based simulation algorithms [2]. This framework allows the creation of complex and realistic simulations that consider the physical properties of objects and their interaction with their surroundings, enabling researchers and developers to predict and simulate the behavior of physical systems.

Student's Tasks Description

- get familiar with SOFA
- analyze existing literature that addresses soft tissue deformation with SOFA
- choose the target organ/tissue and imaging modalities
- conduct experiments and carry on comparative studies

Technical Prerequisites

Good Python Programming level

Optional: Experience with ImFusionSuite

References

- [1] Barua, R., Datta, S., RoyChowdhury, A., & Datta, P. (2022). Study of the surgical needle and biological soft tissue interaction phenomenon during insertion process for medical application: A Survey. Proceedings of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine, 236(10), 1465-1477.
- [2] Faure, F., Duriez, C., Delingette, H., Allard, J., Gilles, B., Marchesseau, S., ... & Cotin, S. (2012). Sofa: A multi-model framework for interactive physical simulation. Soft tissue biomechanical modeling for computer assisted surgery, 283-321