Automatic pipeline generation for the integration of biomechanical simulation and eXtended Reality applications

Project Management and Software Development
for Medical Applications

General Info

Contact Person: Sasan Matinfar, Veronica Ruozzi

Contact Email: sasan.matinfar@tum.de , veronica.ruozzi@polimi.it

Project Abstract

Providing precise and reliable feedback on tool-tissue interaction in eXtended Reality (XR) environments remains a significant challenge. Having a standardize simulated environment for running extensive experiments is crucial for understanding such complex interaction. In this project, we aim to create an automatic pipeline for the integration of biomechanical simulation, and evaluation of audio-visual feedback in an XR application. This project encompasses a comprehensive development framework including modules in SOFA Framework (Open Source software for medical simulations), Processing, and miPhysics (physics-based auditory feedback simulator). This Python-based pipeline will allow the developers to run different benchmarks by changing the input parameters to the simulation for further analysis.

Background and Motivation

Surgical navigation in minimally invasive and robotic surgery is currently a challenge. Mostly in highly dynamic and intraoperative scenarios, such as brain tumours resection or epicardial puncture access, a precise perception regarding the tool position and its interaction with the surrounding anatomy is highly required for the surgical outcomes. However, modelling real-time soft tissue dynamics when subjected to tool interaction requires sophisticated computations and resources, for this reason, it has not yet been integrated in an XR environment.

Student's Tasks Description

Task 1: creating a GUI for fast and easy model configuration, and automatized simulation execution process;

Task 2: developing a middleware for providing the resulting simulation data to the Processing module;

Task 3: implementing an automatized recording process, and creating a sound analysis module from the generated feedback;

Task 4: implementing the visualization of simulation results, spectrograms and sound analysis data in the GUI.

Technical Prerequisites

Good Python knowledge, in particular VTK and ITK.

Preferably Java.

Ideally (not necessarily) C++, audio programming.

References

[1] Schütz, L., Matinfar, S., Schafroth, G., Navab, N., Fairhurst, M., Wagner, A., Wiestler, B., Eck, U. and Navab, N., 2024. A Framework for Multimodal Medical Image Interaction. IEEE Transactions on Visualization and Computer Graphics.

[2] miPhysics: https://github.com/mi-creative/miPhysics_Processing

Please send the completed proposal to tianyu.song@tum.de, shervin.dehghani@tum.de and felix.tristram@tum.de. Please note that this proposal will be evaluated by the BMC coordinators and will be assigned to a student only in case of acceptance.

[3] SOFA Framework: https://www.sofa-framework.org/

[4] Processing: https://processing.org/