Generic topological and physical model for soft tissue simulation.

Karolina Golec

Supervisors: Guillaume Damiand, Florence Zara, Stéphane Nicolle
Institutions: Univ Lyon, Université Lyon 1, CNRS, LIRIS, IFFSTAR, LBMC, LABEX Primes

Introduction

Within the framework of simulators for training of medical procedures, the main issue concerns the interactive simulation of internal organs behavior, taking into account interaction between them and/or with external surgical tools. The goal of this thesis concerns thus the implementation of a new biomedical model of soft tissues suitable for interactive simulations and allowing simulations of organ movements. We want to create a new physical model based on the topological mass-spring system (MSS) and mass-tensor model (MT) of LIRIS by integrating the new behavior laws developed by LBMC and Physic laboratory of ENS.

Methods and Results

In June 2015 we developed an improvement of a unified topological model allowing faster simulation, genericity and easy topological modifications in real time. Additionally, there is no need to perform any pre-computations, which significantly increases the computation time at every topological modification.

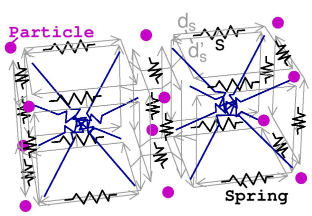

Figure 1: Cmap and its geometry on two cubical mesh elements

Recently we have developed also a new physical model to allow simulation of soft tissues in a non-linear regime. The results of this work are very promising and they are suitable for medical simulation due to their accuracy. Figure 2 presents one of the simulation results in comparison with analytical model.

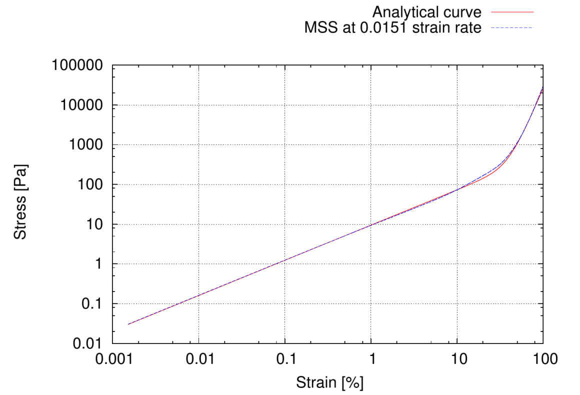

Figure 2: MSS simulation of a liver tissue and the analytical curve: comparison (log-log scale)

Current and Future work

Current work includes a new architecture of the basic shapes used for simulation and implementation of correction forces. The goal is to simulate an isotropic material and be able to use different values of Poisson's ratio. Figure 3 shows an example of such shape in 2D. The model introduces new springs and particles. The future work includes implementation of the new model for different mesh-elements in 2D and 3D. We will also work on refinement and de-refinement of meshes using mixed-type elements.

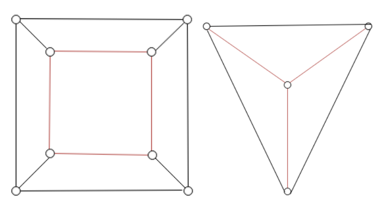

Figure 3: 2D square and triangle model for an isotropic mesh

Acknowledgements

This work is supported by the LABEX PRIMES (ANR-11-LABX-0063) of Universit de Lyon, within the program "Investissements dAvenir" (ANR-11-IDEX-0007) operated by the French National Research Agency (ANR).