Centre Ingénierie et Santé – Mines Saint-Etienne

Postdoc project: Patient-specific Lattice Boltzmann modelling of fluid-solid biomechanical structures.
Duration: 12 months
Location: Centre Ingénierie et Santé – Mines Saint-Etienne – SAINBIOSE UMR INSERM 1059
Speciality: Lattice Boltzmann Method mechanics and image processing
Keywords: Lattice Boltzmann Method, soft tissue, numerical simulation, medical images

Background and project description

Mechanical simulation of biological tissues in the context of medical care leads to better understanding, evaluation ability and improvement of therapies. Today physicians rely strongly on medical images to evaluate pathologies and decide for therapeutic solutions. Besides, the patient-specific simulation of soft tissue has been made possible thanks to medical image processing, more specifically image segmentation methods which give geometrical models to use with simulation tools such as Finite Element Method (FEM). This postdoc's goal is to realize the fusion between mechanical simulation and image processing using the Lattice-Boltzmann Method (LBM), issued from statistical physics. It will explore the possibilities of performing numerical simulations directly from medical images of patients, without the geometrical segmentation step.

The global project aims at developing a workflow starting from medical images and resulting in patient-specific soft tissue simulations. The first results of such workflow have been proposed in a PhD thesis.

Objectives and tasks of the project

The role of the postdoc fellow will be to finalize, optimize and test the image-to-simulation workflow developed in the LBSMI project on real medical data. An in-house LBM code has been already developed, and the postdoc fellow will work on this basis. Comparison with FEM will also be done. The idea will be to develop patient-specific models for personalized medicine thru different applications. To this aim, and following different projects involving researchers of the Lab, databases of medical images are available.

First, the conditions or framework leading to the aneurysm rupture will be assessed using medical images of aneurysms. Fluid-structure simulations based on LBM will be implemented for this task.

A second application will also be investigated: orthosis effectiveness. This application is relatively mastered in the lab and geometric models developed for FEM already exist, as well as patients' images. The two main orthosis types concerned are knee braces and lumbar belts.

Environment

This postdoc position is part of LBSMI - Lattice Boltzmann Simulation from Medical Images – project (2016-2020) awarded to Laurent Navarro by ANR (Agence Nationale de la Recherche – French National Research Agency). His group located at "Centre Ingénierie et Santé" (Center for Biomedical and Healthcare Engineering at Mines Saint-Etienne) focuses on tissue biomechanics through experimental, numerical studies and fundamental researches. The

LBSMI project relies on collaborations with Saint-Etienne University Hospital and CREATIS-INSA (Lyon)

Student profile

PhD in Physics, mathematics or computational mechanics.
Motivation for theoretical challenges and computational work are essential.
Background in Lattice Boltzmann Method and good knowledge in continuum mechanics would be an advantage.

Administrative aspects

The employer is Mines Saint-Etienne, one of the most prestigious engineering schools in France. This postdoc is funded for **12 months**, starting in **july, 2019**.

Interested students will send curriculum vitae, a cover letter describing previous research experience and interests, and two recommendation letters in support - Submission via email with "ANR LBSMI postdoc" on the subject line to Laurent NAVARRO (navarro@emse.fr).