PhD position at the Center for Biomedical and Healthcare Engineering

Mines Saint-Etienne – SAINBIOSE (UMR INSERM UJM EMSE)

LATTICE BOLTZMANN SIMULATION OF SOFT TISSUE

Keywords: Lattice Boltzmann method, soft tissue, numerical simulation, medical images

Academic context: This PhD 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).

Scientific context: 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 PhD will 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 of soft tissue directly from medical images of patients, without the geometrical segmentation step.

Project summary: The LBSMI project objective is to develop a workflow starting from medical images and resulting in patient-specific soft tissue simulations. Such workflow does not exist at this moment, because current numerical methods employed in biomechanics such as Finite Element Method need a geometrical model that has to be built from medical image data. The PhD's work will be: (1) to adapt the Lattice Boltzmann equations for soft tissue simulation, (2) to address the problem of automatic material parameters extraction from medical images and (3) to set up a comprehensive workflow for predicting tissue deformations under certain loading conditions without prior segmentation.

Student profile: 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 PhD is funded for 36 months, starting in January 2016.

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 PhD" on the subject line to Laurent NAVARRO, PhD (navarro@emse.fr)