2023-06604 – Post-Doctoral Research Visit F/M
Postdoctoral researcher in Fast Finite Element simulation using Model order reduction in the context of percutaneous liver tumor ablation.

**About the research centre or Inria department**

The Inria Lille - Nord Europe research centre, created in 2008, has a staff of 360, including 305 scientists in 15 research teams. Recognised for its strong involvement in the socio-economic development of the Hauts-De-France region, the Inria Lille - Nord Europe research centre pursues a close relationship with large companies and SMEs. By promoting synergies between researchers and industrialists, Inria participates in the transfer of skills and expertise in digital technologies and provides access to the best European and international research for the benefit of innovation and companies, particularly in the region.

For more than 10 years, the Inria Lille - Nord Europe centre has been located at the heart of Lille's university and scientific ecosystem, as well as at the heart of Frenchtech, with a technology showroom based on Avenue de Bretagne in Lille, on the Euratechnologies site of economic excellence dedicated to information and communication technologies (ICT).

**Context**

Defrost team at Inria ([https://team.inria.fr/defrost/](https://team.inria.fr/defrost/)) focuses on the modeling, simulation and control of soft deformable robots ([https://en.wikipedia.org/wiki/Soft_robotics](https://en.wikipedia.org/wiki/Soft_robotics)). Our vision is that future robots don't have to be «rigid» but made of complex deformable structures, composed of stiff and soft regions, close to organic materials that we can find in the nature. Soft robotics opens very attractive perspectives in terms of new applications, reduction of manufacturing costs, robustness, efficiency and security. It could result in great advances in robotics in the next years.

The researchers and software developers within the team are using the open source SOFA simulation framework ([https://www.sofa-framework.org](https://www.sofa-framework.org)) for which we have developed several plugins, including the plugin MOR for model order reduction based on projection using Proper Orthogonal Decomposition (POD).

**ANR Specular**

The project SPECULAR, funded by the ANR has 4 partners: MIMESIS team at Inria Nancy, AVR team at Strasbourg University, DEFROST team at Inria Lille and the company InfinyTech3D. The main goal of the project is to provide a realistic simulator of percutaneous liver tumor ablation surgery in Virtual Reality. This corresponds to several interventions such as biopsy of radiofrequency ablation. This involves developing a realistic and interactive finite element (FE) simulation of the needle insertion into the human body, including the interaction between the different neighboring organs, stomach, pancreas, intestine or diaphragm. Within this project, the DEFROST team tasks are related to computational efficiency to achieve the real-time constraint of the simulation to allow for smooth surgery training.

**Assignment**

As a member of the ANR project, the recruited Postdoctoral researcher will focus more specifically on the computational efficiency of the FE simulation. Indeed, that kind of simulation involving several organs in contact is typically expensive for several reasons:

- the finite element mesh of the liver has to be fine to account accurately for its deformation when punctured by a needle
- the computation of the interaction constraints between the needle and the liver
- the multiple contact interactions between all the surrounding deformable organs (stomach, pancreas, etc.)

**Main activities**

Several strategies linked to several research topics will be explored:

- Using model order reduction to speed up the computation time of the FE models of organs surrounding the liver. ([https://hal.inria.fr/hal-01834483v1](https://hal.inria.fr/hal-01834483v1))
- A special care will be taken to select the snapshot space to guarantee the accuracy of the surrogate.
- Speed up contact force computations using contact modes. ([https://hal.inria.fr/hal-03192762](https://hal.inria.fr/hal-03192762))
- Parallel computing strategies using for example GPU. ([https://doi.org/10.1117/cgf.14563](https://doi.org/10.1117/cgf.14563))
- Using a Mixed full FEM and Reduced model for the liver to compute very accurately deformation around the needle and more coarsely further away. Could get inspiration from ([https://hal.inria.fr/hal-00696504v1](https://hal.inria.fr/hal-00696504v1))

The plugin [ModelOrderReduction](https://github.com/SofaDefrost/ModelOrderReduction) for SOFA developed in the team will be used and extended.

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**Inria Team :** DEFROST

**Recruiter :** Duriez Christian / Christian.Duriez@inria.fr

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**General Information**

- **Theme/Domain :** Robotics and Smart environments
- **Town/City :** Villeneuve d’Ascq
- **Inria Center :** Centre Inria de l’Université de Lille
- **Starting date :** 2023-10-01
- **Duration of contract :** 6 months
- **Deadline to apply :** 2023-08-13

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**Instruction to apply**

- **Application to Inria.** Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.

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**Warning**

You must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.
Skills
- C++ and Python programming
- Knowledge of software development practices (test framework, continuous integration, Git...)
- Ability to write documentation and scientific papers in English

Benefits package
You will join a dynamic team of international scientific experts in the field of robotics (https://team.inria.fr/defrost/).
You contribute to the development of a complex software internationally recognized in the field of open science/digital.
You will work in a stimulating and pleasant working environment (participation in transportation (50%), teleworking, leave and special leave of absence (45 days), videoconference equipment, technical experimentation laboratory...).
In addition to improving your technical skills, Inria offers you the opportunity to develop your entrepreneurial skills by participating in awareness events and training on start-up creation (start-up horizon, intellectual property training, hackAthon... see https://www.inria.fr/en/inria-startup-studio/)
For international candidates, our administrative services will help you through the various administrative procedures (visa, residence permit, social security, bank...).

Remuneration
2,788€ gross per month