2018-00435 - [Campagne Doctorant 2018/CRI LILLE] - PhD
Thesis : Design and simulation of Soft Robots made of
meso-structured materials (M/F)

Contract type : Public service-fixed-term contract
Level of qualifications required : Graduate degree or equivalent
Fonction : PhD Position

About the research centre or Inria department

The Inria Lille - Nord Europe Research Centre was founded in 2008 and employs a staff of 360, including 300 scientists working in sixteen research teams. Recognised for its outstanding contribution the socio-economic development of the Nord - Pas-de-Calais Region, the Inria Lille - Nord Europe Research Centre undertakes research in the field of computer science in collaboration with a range of academic, institutional and industrial partners.

The strategy of the Centre is to develop an internationally renowned centre of excellence with a significant impact on the City of Lille and its surrounding area. It works to achieve this by pursuing a range of ambitious research projects in such fields of computer science as the intelligence of data and adaptive software systems. Building on the synergies between research and industry, Inria is a major contributor to skills and technology transfer in the field of computer science.

Context

Job environnements :

This PhD will be based in the Inria team DEFROST (https://team.inria.fr/defrost/) in Lille, co-supervised by Olivier Goury (olivier.goury@inria.fr) and Christian Duriez (christian.duriez@inria.fr) and will be done in collaboration with Sylvain Lefebvre from the Inria ALICE (https://www.inria.fr/en/teams/alice) team in Nancy.

The candidate will be based in Lille and spend 6 months in Nancy.

Assignment

Assignments

Soft robotics is a new development in robotics where robots are made of soft materials, providing them properties of compliance which can have advantages in many applications. The current state of the art for building soft-robots is to 3D-print a mold in which the silicone will be casted, thus creating a soft structure of the desired geometry. The amount of control on the resulting material properties is limited to stiffness by varying the type of silicone. Meta-materials, like meso-structured materials, are materials having a specific micro-structured tile that may be periodic, providing them specific macroscopic mechanical properties. These properties would be interesting to use with soft robots by providing some specific properties such as the anisotropy of being stiffer in one direction.

In the project-team DEFROST, https://team.inria.fr/defrost, a software dedicated to real-time Finite Element Method (FEM) simulation of soft robots and their environment for design and control is being developed. This software is based on the open source framework SOFA and can handle all kinds of material geometries in interaction with their environment. However, when dealing with meso-structured materials, using a standard FEM model becomes prohibitively expensive, since the underlying mesh describing the material has to be extremely fine, the size of its elements being linked to the scale of the micro-structure. To be able to tackle such materials, it is necessary to use some homogenization method (a well known method in mathematical mechanics to simulate heterogeneous materials) to be able to find a macro-scale description of the material deformation taking the micro-structure into account. Those methods are typically based on the analytical or numerical evaluation of the behaviour of a micro-scale tile of the material to define a law of deformation at the macro-scale.

Bibliography:

Software toolkit for modeling, simulation, and control of soft robots (2017), E. Coevoet et al.

Microstructures to Control Elasticity in 3D Printing (2015), Christian Schumacher et al.


General Information

- Theme/Domain : Robotics and Smart environments
- Scientific computing (BAP E)
- Town/city : Villeneuve d’Ascq
- Inria Center : CRI Lille - Nord Europe
- Starting date : 10/1/18
- Duration of contract : 3 years
- Deadline to apply : 5/2/18

Contacts

- Inria Team : DEFROST
- Recruiter : Goury Olivier / olivier.goury@inria.fr

The keys to success

The candidate should have a background in scientific computing, computational mechanics, computer science, or any related field.

- Interest for multi-disciplinary subject
- Strong motivation, will to learn
- Ability to work in a team
- Good relational skills

Conditions for application

Instructions to apply

Candidates will be treated firstly with a complete file : CV + letter of motivation + one or more letters of recommendation + transcripts from previous years.

Defence Security :

This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST). Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

Recruitment Policy :

As part of its diversity policy, all Inria positions are accessible to people with disabilities.

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.
Elastic Textures for Additive Fabrication (2015), J. Panetta et al.
A framework for data-driven analysis of materials under uncertainty: Countering the curse of dimensionality (2017), MA Bessa et al.
Automatised selection of load paths to construct reduced-order models in computational damage micromechanics: from dissipation-driven random selection to Bayesian optimization (2016), O. Goury et al.

Main activities

The candidate will develop a numerical framework to simulate the mechanical behaviour of microstructured materials in the open source framework SOFA: https://www.sofa-framework.org.

This tool will allow the candidate to design a proof of concept of meso-structured soft robots in the SOFA simulation environment and then to manufacture it.

If time remains, he may then investigate the design of optimal shapes of microstructures which have specific beneficial properties for soft robotics. Methods coming from the machine learning community may be used, or other methods the candidate may wish to use or develop.

The candidate will contribute to the team projects, publish in international journals and conferences.

Skills

Knowledge in programming: C/C++, Python, etc...
Version: Git
Languages: English, French is a plus but not necessary

Benefits package

Benefits
- Subsidised catering service
- Partially-reimbursed public transport
- Social security
- Paid leave
- Sports facilities
- Flexible working hours

More information about Lille:
http://www.lille3000.eu/portail/
http://www.lillemetropole.fr/mel.html

Remuneration

Remunerating

The gross monthly salary is 1982€ for the 1st and 2nd year, 2085€ for 3rd year.