Inferring mechanical properties of plant cells from imaging and atomic force microscopy - IMAGINE

Type d'offre : Doctorant
Lieu de travail : Grenoble (Montbonnot)
Thème de recherche : Perception, cognition, interaction
Projet : IMAGINE
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Date limite de candidature: 30/06/2012

A propos d'Inria et du poste

INRIA, the French national institute for research in computer science and control, is dedicated to fundamental and applied research in information and communication science and technology (ICST). INRIA has a workforce of 3,800 people working throughout its eight research centers established in seven regions of France.

The aerial architecture of plants depends on the activity of small groups of undifferentiated stem cells called meristems that initiate most of the adult plant organs (axes, leaves, flowers, etc.). Once the organs and tissues are initiated, they expand to reach their final shape. Little is currently understood on the genetic and cellular origin of these growth phenomena. The goal of the INRIA project Morphogenetics is to analyze and model the physiological and mechanical processes that control the initiation and development flower organs.

To address this question, Morphogenetics offers 2 PhD positions aiming to model meristem mechanics at different scales. These theses will help building mathematical and computational tools to address how shapes are achieved by meristem, a process known as morphogenesis. The first PhD project (described hereafter) will focus on the mechanical properties of groups of few cells in a static meristem, based on mechanical tests. The project will build on the strengths of the two teams involved, in the physically-based animation of 3D content and in the mechanics of plant tissues.The second PhD project will address the mechanics of organ development during meristem growth based on imaging information about meristem shape observed in laser microscopy.

Descriptif du poste

As shape is determined by structural, mechanical elements, it is essential to investigate the mechanics of complex living tissues at cell resolution. The main objective of this thesis is to infer the mechanical parameters of a plant cell based on mechanical tests. This belongs to a wider collaboration, aiming to unravel the role of mechanics in plant morphogenesis, and involving biologists, biophysicists, computer scientists, and applied mathematicians.

The project will be co-supervised by Arezki Boudaoud (Lyon) and François Faure (Grenoble). In Lyon, advanced micro-indentation techniques and high-resolution atomic microscopy imaging are used in mechanical tests of plant tissue, and experimental data are already available. This, and the results of upcoming experiments, will be used to infer mechanical parameters such as elastic modulus, viscosity... To do so, detailed numerical representations of a small group of cells will be built using either classical engineering models such as finite elements or more advanced methods based on meshless influence frames. Numerical algorithms to solve the so-called inverse problems will help identifying the best mechanical model for the plant cell as well as model parameters, starting from measured displacements and forces. This will be implemented using the C++ mechanical library SOFA developped in Grenoble.

The results will help plant biologists to find how genes encode mechanical properties and so prescribe morphogenesis. The work will benefit from interactions with the other PhD project in Montpellier that focuses on mechanical models of plant growth at larger scales. A main challenge of the present project will be to deal with heterogeneous and complex materials, and the solutions found should have a strong impact on other fields such as biomechanics, medical imaging, or material science... Therefore the work should be at the level of the best international scientific journals.

Profil recherché

Main background in either mechanical engineering, computer science, applied mathematics or computational physics.
Good skills in continuum mechanics and programming. Knowledge of the finite element method would be an asset.

Avantages

Duration: 36 months
Salary: around 1957€ gross/month.
Monthly salary after taxes : around 1597€ (medical insurance included).

Informations complémentaires

http://imagine.inrialpes.fr/
http://www.ens-lyon.fr/RDP/Biophysics-and-development

Protection of scientific and technological assets.
Over the last decade, the field of information and communication science and technologies has grown considerably. And this growth is set to continue. In all countries, the sector is a key area of development, with strategic importance. INRIA is a public research organisation entirely devoted to R&D in this field. While the majority of its research results and development

activities are public and can be found in various publications, certain results and activities are subject to a high degree of confidentiality in order to protect the scientific and economic potential of France and Europe.

Welcoming visitors
In the interests of protecting these assets, according to the law no 2011-1425 from november, 2 2011 implementing 413-7 article of the penal code about protection of scientific and technological assets, any visitors must be authorized by the Institute's Security and Defence Official and receive formal approval from the Senior Defence and Security Official reporting to the French Minister of Higher Education and Research.
These regulations require the examination of the credentials of any person who wishes to work with the institute, regardless of their status (researcher, post-doc, PhD student, intern, etc.), taking into account the sensitivity of the research. As a result, permission for proposed visits may be refused.

Before applying, it is advised to contact the scientific advisor for more information on the research project (his email is above-mentioned). You can also ask the HR contact for any administrative or practical information.