2018-00782 - 3D segmentation and growth tracking of plant point clouds in field conditions

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

About the research centre or Inria department

Grenoble Rhône-Alpes Research Center groups together a few less than 800 people in 35 research teams and 9 research support departments.

Staff is localized on 5 campuses in Grenoble and Lyon, in close collaboration with labs, research and higher education institutions in Grenoble and Lyon, but also with the economic players in these areas.

Present in the fields of software, high-performance computing, Internet of things, image and data, but also simulation in oceanography and biology, it participates at the best level of international scientific achievements and collaborations in both Europe and the rest of the world.

Context

The European project ROMI aims at developing an open lightweight robotics platform for crop monitoring and weed reduction in small farming land areas. This platform will be equipped with imaging sensors and software to reconstruct and analyze plants in 3D. Within this project, the proposed PhD position will be at the core of the data processing pipeline. More specifically, the data acquisition and conversion to 3D point clouds will be done by a team at CNRS (Lyon, France) and a team at Sony CSL (Paris, France), while plant architecture models and parameter extraction methods for these models will be developed by teams at CNRS and Inria (Lyon, France). In coordination with them, the hired PhD student will be in charge of developing new mathematical and algorithmic tools to segment a plant (represented as a 3D point cloud) into its organs and track these organs through time.

Location

Strasbourg, France, with several stays in Lyon, France

Le doctorant sera hébergé par l'équipe IGG à Strasbourg, où l'encadrant principal de la thèse travaille. Plusieurs séjours à Lyon dans l'équipe MOSAIC sont prévus pendant la thèse.

Assignment

The overall goal of the PhD is to develop new tools to segment a 3D model of a plant into its organs and to track their growth. *Arabidopsis thaliana* and *Chenopodium album* will be the two species taken as examples. The input 3D model is a noisy point cloud with non-uniform density and missing data, due to occlusions.

Main activities

The first stage of the PhD will be to automatically and independently segment each point cloud into the plant's organs (especially stems and leaves), without any prior knowledge on the species. Existing methods often assume a clean 3D point cloud (e.g., [1,2]). Others are either destructive [3], plant-specific [4] or not fully automatic [5,6]. Similar to [2,6], a spectral clustering approach will be considered, but local geometric information around each point of the cloud should first be better estimated despite the noise and varying density. Hence, a first work will be to develop a method for...
robust local surface estimation and compare to the related work [7].

The second stage will deal with the tracking of each organ. Compared to the more usual case of human characters, this is challenging since the geometry of the organs drastically changes during the growth, which makes usual rigidity or isometry assumptions impossible. Some organs may even appear or disappear during the growth process. Previous work on this topic has shown that impressive results can be obtained for plants acquired in a controlled environment [8]. As noted in [8] the problem is more complex in the case of noisy point clouds of plants with large leaves, though a recent work proposes a solution for blooming flowers with a fixed number of petals [9]. Both these works demonstrate that a double forward-backward matching process is necessary to efficiently track growing leaves even if they collide or in case of occlusions, and that it could refine the segmentation. Nevertheless, using a simple template model as in [9] is impossible in our more complex case because the number of organs can vary through time. As for humans in wide clothing [10], we therefore plan to start with sparse one-to-one point correspondences and then define a local deformation model.

In the third and last stage of the PhD, prior knowledge about the plant architecture will be integrated to the process in order to make both the segmentation and the tracking more robust. This will be done in collaboration with other partners of the ROMI project and is expected to generate fully consistent 3D+t architectures that faithfully interpret the collected data. The performance of this pipeline will be evaluated against the results provided by machine learning approaches directly applied to the 3D point clouds developed by another partner.

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

Remuneration
Monthly salary after taxes: around 1596,05€ for 1st and 2nd year. 1678,99€ for 3rd year. (medical insurance included).

General Information
- **Theme/Domain**: Computational Biology
- **Town/city**: Strasbourg
- **Inria Center**: CRI Grenoble - Rhône-Alpes
- **Starting date**: 2018-10-01
- **Duration of contract**: 3 years
- **Deadline to apply**: 2018-07-31

Contacts
- **Inria Team**: MOSAIC
- **Recruiter**: Boyer Sylvie / sylvie.boyer@inria.fr

About Inria
Inria, the French National Institute for computer science and applied mathematics, promotes "scientific excellence for technology transfer and society". Graduates from the world's top universities, Inria's 2,700 employees rise to the challenges of digital sciences. With its open, agile model, Inria is able to explore original approaches with its partners in industry and academia and provide an efficient response to the multidisciplinary and application challenges of the digital transformation. Inria is the source of many innovations that add value and create jobs.

Conditions for application
- **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.