Offer #2019-01606

PhD Position F/M at CEA Leti : Deep Learning for 3D reconstruction in lensfree microscopy

Contract type : Fixed-term contract

Level of qualifications required : Graduate degree or equivalent

Fonction : PhD Position

About the research centre or Inria department

Leti is an institute of CEA, a French research-and-technology organization with activities in energy, IT, healthcare, defence and security. Leti is focused on creating value and innovation through technology transfer to its industrial partners. It specializes in nanotechnologies and their applications, from wireless devices and systems, to biology, healthcare and photonics. NEMS and MEMS are at the core of its activities. In addition to Leti's 1,700 employees, there are more than 250 students involved in research activities, which makes Leti a mainspring of innovation expertise. Leti's portfolio of 1,880 families of patents helps strengthen the competitiveness of its industrial partners.

Context

The PhD student will be supervised at **CEA Leti** by Dr. Cédric Allier (HDR) and Dr. Lionel Hervé (HDR) and by Dr. Sergei Grudinin at **Inria**. It will evolve in an environment at the interface between optical instrumentation, digital processing and cell biology. This thesis will therefore offer the possibility of following a solid training in applied research with a strong transversality. The skills of the doctoral student in digital processing will be in depth and the successful work will open opportunities in the field of biomedical imaging.

Assignment

Pour une meilleure connaissance du sujet de recherche proposé :

At **CEA-Leti**, we are developing lensfree microscopy for the monitoring of cell culture. This technique overpass several limits of conventional microscopy (compactness, field of view, quantification, etc.). Recently we showed, for the first time, 3D+time acquisitions of 3D cell culture with a lens-free microscope. We observed cells without any labelling within the volume as large as several cubic millimeters over several days. This new mean of microscopy allowed us to observe a broad range of phenomena only present in 3D environments. However, two drawbacks are still present on the microscope prototype: a long reconstruction time (>1 hour/frame) and the reconstructed volumes present artefacts owing to the limited number of angular acquisitions. The thesis work will focus on the ability of deep learning technologies to overcome the above-mentioned limitations. Basically, a convolutional neural network will be trained on the basis of simulated 3D cell culture volume (ground truth) and simulated response of our current 3D lensfree microscope (input). This approach is expected to accelerate the reconstruction process and to allow full 3D reconstructions. Yet it poses two scientific questions: are simulated data pertinent to train a neural network and how can we assess the quality of 3D reconstruction obtained through a neural network?

References:

- [Nature Photonics 2013] Mudanyali, et al. (2013). Wide-field optical detection of nanoparticles using on-chip microscopy and self-assembled nanolenses. Nature photonics, 7(3), 247.
- [Nature Scientific Reports 2018] Berdeu et al.. (2018). Lens-free microscopy for 3D+ time acquisitions of 3D cell culture. Scientific reports, 8(1), 16135.
- [U-NET] RONNEBERGER, et al.. U-net: Convolutional networks for biomedical image segmentation. In : Int. Conference on Medical image computing and computer-assisted intervention. Springer, Cham, 2015. p. 234-241.
- [CARE] M. Weigert, et al. "Content-aware image restoration: pushing the limits of fluorescence microscopy," Nat. Methods, p. 1, 2018.
- [ref NN-SPEED] Rivenson et al. (2018). Phase recovery and holographic image reconstruction using deep learning in neural networks. Light: Science & Applications, 7(2), 17141.

Main activities

Main activities :

- development of novel algorithms
- writing source code
- constructing benchmarks with synthetic data
- validation of methods on real data
- writing technical reports and scientific manuscripts

Skills

Profile of the candidate:

- Engineering degree in applied mathematics or physical sciences.
- Strong knowledge in image processing with skills in deep learning.

Benefits package

- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 5 weeks and 3 days of annual leave + 24 extra days off due to RTT (statutory reduction in working
- hours) + possibility of exceptional leave (sick children, etc.)
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

Remuneration

Salary (before taxes) : 2050€ gross/month for 1st and 2nd year. 2100€ gross/month for 3rd year.

General Information

- **Theme/Domain :** Optimization, machine learning and statistical methods
  Scientific computing (BAP E)
- **Town/city :** Grenoble
- **Inria Center :** Centre Inria de l'Université Grenoble Alpes
- **Starting date :** 2019-10-01
- **Duration of contract :** 3 years
- **Deadline to apply :** 2019-06-30

Contacts

- **Inria Team :** NANO-D
- **PhD Supervisor :**
  Grudinin Sergey / sergei.grudinin@inria.fr

About Inria

Inria is the French national research institute dedicated to digital science and technology. It employs 2,600 people. Its 200 agile project teams, generally run jointly with academic partners, include more than 3,500 scientists and engineers working to meet the challenges of digital technology, often at the interface with other disciplines. The Institute also employs numerous talents in over forty different professions. 900 research support staff contribute to the preparation and development of scientific and entrepreneurial projects that have a worldwide impact.

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.

Instruction to apply

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.