



Offer #2024-08530

PhD Position F/M [Campagne Allocation Région 2025] Robotization of Cochlear Implant Insertion Surgery: Modeling, Simulation, and Control (F/H)

Contract type : Fixed-term contract

Level of qualifications required : Graduate degree or equivalent

Fonction : PhD Position

About the research centre or Inria department

Created in 2008, the Inria center at the University of Lille employs 360 people, including 305 scientists in 15 research teams. Recognized for its strong involvement in the socio-economic development of the Hauts-De-France region, the Inria center at the University of Lille maintains a close relationship with large companies and SMEs. By fostering synergies between researchers and industry, Inria contributes to the transfer of skills and expertise in the field of digital technologies, and provides access to the best of European and international research for the benefit of innovation and businesses, particularly in the region.

For over 10 years, the Inria center at the University of Lille has been 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

According to the statistic of World Health Organization, over 5% of the world's population, i.e., 360 million people, has disabling hearing loss (328 million adults and 32 million children). **Cochlear implant surgery** can be used for profoundly deafened patient, for whom hearing aids are not satisfactory, and it is regarded as one of the best options for better hearing. **During the implant surgery, the most difficult task is to insert the electrode** array into the tympanic ramp of the patient's cochlea. The implant is normally made of silicone (thus very soft), the surgery is performed manually because the cochlear implant is totally passive and the surgeon has no perception on what happens in the cochlea while he/she is doing the insertion.

This thesis aims to significantly advance the automation of cochlear implant insertion, progressing from TRL 3 to TRL 6. It is partially funded by the ANR PRCE project ACCESS and seeks to address critical challenges in the modeling, simulation, and control of active Thin-Film Electroactive Actuators (TFEAs) for cochlear implantation. A primary focus of the research is to develop robust solutions for navigating the complex anatomy of the cochlea and its surrounding deformable structures, which present significant challenges for both the design of the implant and the precision of its insertion.

Assignment

In our former ROBOCOP project, we developed modeling techniques for ECP and TFEA actuators, as well as control strategies for both passive and active cochlear implant insertions. However, to further enhance the level of robotization in implant insertion, it is crucial to consider not only the cochlea and the cochlear implant but also the surrounding anatomical structures, such as blood vessels, the facial nerve, and bones.

This requires:

- **Modeling of soft tissues and deformable organs** interacting with the active implant.
- **Development of an innovative simulator** that integrates the active implant, surrounding anatomical structures, and a robotic manipulator.

These new elements increase the complexity of trajectory planning and optimal control for insertions, necessitating a thorough reevaluation. The inclusion of anatomical structures imposes additional constraints, such as avoiding sensitive nerves.

This work will be conducted in close collaboration with IEMN (CNRS) for the modeling, the R&D department of Cochlea Company for the simulation, and the Institut de l'Audition (Institut Pasteur) for the validation. By combining modeling, simulation, real-time control strategies, and rigorous validation, it aims to contribute

to the technological advancement of soft robotics in medical applications, particularly in the field of cochlear implantation.

Application Process: Please send your detailed CV, cover letter, and Bachelor's and Master's transcripts to: gang.zheng@inria.fr, christian.duriez@inria.fr, and yinoussa.adagolodjo@inria.fr

Main activities

We aim to model the entire robotic system (manipulator and active implant), design an optimal control strategy, and collaborate to develop real-time simulations. This will enable the creation of an automated or semi-automated implant insertion process.

Main Tasks:

1. Modeling:

- Develop multiphysics models integrating the dynamics of active TFEAs, the cochlea, and surrounding anatomical structures.
- Employ advanced techniques such as Cosserat beam theory and finite element methods (FEM).
- Generate patient-specific models using high-resolution CT scans.

2. Simulation:

- Develop real-time numerical simulations with the SOFA framework to create digital twins of cochlear implantation.
- Optimize implant geometry and plan surgical interventions.

3. Optimization and Control:

- Design trajectory planning and closed-loop control strategies to avoid anatomical damage while ensuring precise implantation.

4. Validation:

- Validate the models and simulations using clinical data and preclinical experiments.
- Perform hardware tests and preclinical trials to evaluate the performance of the developed strategies.

Skills

Requirements: Master's degree in Robotics, Control, Computer Science, Engineering, or related fields. Experience with C/C++, Python, and SOFA. Ability

to work independently.

Benefits package

- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)
- Possibility of teleworking and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

Remuneration

2200 € monthly gross salary from October to December 2025

2300 € monthly gross salary after January 1st 2026

General Information

- **Theme/Domain** : Robotics and Smart environments
Instrumentation et expérimentation (BAP C)
- **Town/city** : Villeneuve d'Ascq
- **Inria Center** : [Centre Inria de l'Université de Lille](#)
- **Starting date** : 2025-10-01
- **Duration of contract** : 3 years
- **Deadline to apply** : 2025-04-20

Contacts

- **Inria Team** : [DEFROST](#)
- **PhD Supervisor** :
Zheng Gang / Gang.Zheng@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

Please send your CV and cover letter.

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.