



**Offre n°2024-08530**

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

*Le descriptif de l'offre ci-dessous est en Anglais*

**Type de contrat :** CDD

**Niveau de diplôme exigé :** Bac + 5 ou équivalent

**Fonction :** Doctorant

**A propos du centre ou de la direction fonctionnelle**

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).

**Contexte et atouts du poste**

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.

## Mission confiée

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

## Principales activités

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.

## Compétences

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

to work independently.

## Avantages

- 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

## Rémunération

2200 € monthly gross salary from October to December 2025

2300 € monthly gross salary after January 1st 2026

## Informations générales

- **Thème/Domaine** : Robotique et environnements intelligents  
Instrumentation et expérimentation (BAP C)
- **Ville** : Villeneuve d'Ascq
- **Centre Inria** : [Centre Inria de l'Université de Lille](#)
- **Date de prise de fonction souhaitée** : 2025-10-01
- **Durée de contrat** : 3 ans
- **Date limite pour postuler** : 2025-04-20

## Contacts

- **Équipe Inria** : [DEFROST](#)
- **Directeur de thèse** :  
Zheng Gang / [Gang.Zheng@inria.fr](mailto:Gang.Zheng@inria.fr)

## A propos d'Inria

Inria est l'institut national de recherche dédié aux sciences et technologies du numérique. Il emploie 2600 personnes. Ses 215 équipes-projets agiles, en général communes avec des partenaires académiques, impliquent plus de 3900 scientifiques pour relever les défis du numérique, souvent à l'interface d'autres disciplines. L'institut fait appel à de nombreux talents dans plus d'une quarantaine de métiers différents. 900 personnels d'appui à la recherche et à l'innovation contribuent à faire émerger et grandir des projets scientifiques ou entrepreneuriaux qui impactent le monde. Inria travaille avec de nombreuses entreprises et a accompagné la création de plus de 200 start-up. L'institut s'efforce ainsi de répondre aux enjeux de la transformation numérique de la science, de la société et de l'économie.

**Attention:** Les candidatures doivent être déposées en ligne sur le site Inria. Le traitement des candidatures adressées par d'autres canaux n'est pas garanti.

## Consignes pour postuler

Please send your CV and cover letter.

### **Sécurité défense :**

Ce poste est susceptible d'être affecté dans une zone à régime restrictif (ZRR), telle que définie dans le décret n°2011-1425 relatif à la protection du potentiel scientifique et technique de la nation (PPST). L'autorisation d'accès à une zone est délivrée par le chef d'établissement, après avis ministériel favorable, tel que défini dans l'arrêté du 03 juillet 2012, relatif à la PPST. Un avis ministériel défavorable pour un poste affecté dans une ZRR aurait pour conséquence l'annulation du recrutement.

### **Politique de recrutement :**

Dans le cadre de sa politique diversité, tous les postes Inria sont accessibles aux personnes en situation de handicap.