Offer #2025-08945

PhD Position F/M Modeling the dynamic behavior of implants used in total hip arthroplasty

Contract type : Fixed-term contract

Level of qualifications required : Graduate degree or equivalent

Fonction : PhD Position

About the research centre or Inria department

The Inria centre at Université Côte d'Azur includes 42 research teams and 9 support services. The centre's staff (about 500 people) is made up of scientists of di?erent nationalities, engineers, technicians and administrative staff. The teams are mainly located on the university campuses of Sophia Antipolis and Nice as well as Montpellier, in close collaboration with research and higher education laboratories and establishments (Université Côte d'Azur, CNRS, INRAE, INSERM ...), but also with the regiona economic players.

With a presence in the fields of computational neuroscience and biology, data science and modeling, software engineering and certification, as well as collaborative robotics, the Inria Centre at Université Côte d'Azur is a major player in terms of scientific excellence through its results and collaborations at both European and international levels.

Context

The funding of this PhD thesis is granted by the ANR project “MoDyBe” (Modeling the Dynamic Behavior of implants used in total hip arthroplasty), which also involves the Multiscale modeling and simulation laboratory (CNRS, Paris-Est Créteil University), together with clinical partners from the department of

orthopaedic (Henri Mondor hospital).

Assignment

Description of the project:

Cementless implants are increasingly used in clinical practice. They are inserted in the host bone using impacts performed with an orthopaedic hammer (press-fit procedure). However, the rate of revision surgery is still high, which is a public health issue of major importance.
The press-fit phenomenon occurring at implant insertion induces biomechanical effects in the bone tissues, which should ensure implant primary stability (that is, the stability of the implant during the surgery). Despite a routine clinical use, implant failures, which may have dramatic consequences, still occur and are difficult to anticipate.
Just after surgery, the implant fixation relies on the pre-stressed state of bone tissue around the implant. In order to avoid aseptic loosening, a compromise must be found by the surgeon. On the one hand, sufficient primary stability can be ensured by minimizing micromotion at the bone-implant interface in order to promote osteointegration phenomena. On the other hand, excessive stresses in bone tissue around the implant must be avoided, as they may lead to bone necrosis or fractures.
This raises the following mathematical issues:
– What is the appropriate mechanical model of the implant insertion process into the bone?
– What are the suitable high-performance computing methods to accurately solve the above modelling equations for the bone-implant interaction subject to dynamic excitations?
– Which robust inversion approaches can be employed to retrieve the quantities of interest of the bone-implant interaction such as the bone-implant contact area?
During the PhD thesis, after a bibliographical review, the successful candidate will investigate possible dynamic models described by partial differential equations and their possible simplifications. Inversion aspects of the problem will be considered such as reconstruction of the material (bone) parameters and estimation of the stability characteristics of the implant. Anticipating the need for real-time performance, reduced order modelling aspects should be studied.

Main activities

Research, transfer.

Skills

Required skills:

General interest in applied mathematics and modelling in physics or life sciences, theoretical and practical experience with numerical methods for partial differential equations. Experience in continuum modelling, solution of inverse problems and model-order reduction techniques would be highly appreciated.

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 (after 6 months of employment) 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
- Contribution to mutual insurance (subject to conditions)

Remuneration

Duration: 36 months
Location: Sophia Antipolis, France
Gross Salary per month: 2200€ (2025) 2300€ (2026)

General Information

- **Theme/Domain :** Optimization and control of dynamic systems
  Scientific computing (BAP E)
- **Town/city :** Sophia Antipolis
- **Inria Center :** Centre Inria d'Université Côte d'Azur
- **Starting date :** 2025-10-01
- **Duration of contract :** 3 years
- **Deadline to apply :** 2025-08-31

Contacts

- **Inria Team :** FACTAS

- **PhD Supervisor :**
  Leblond Juliette / Juliette.Leblond@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

Applications must be submitted online on the Inria website. Collecting applications by other channels is not guaranteed.

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.