Offer #2024-08492

Post-Doctoral Research Visit F/M Numerical modeling of blood flow in HLHS patients for clinical decision support

Contract type : Fixed-term contract

Renewable contract : Yes

Level of qualifications required : PhD or equivalent

Fonction : Post-Doctoral Research Visit

About the research centre or Inria department

The Inria Saclay-Île-de-France Research Centre was established in 2008. It has developed as part of the Saclay site in partnership with **Paris-Saclay University** and with the **Institut Polytechnique de Paris** .

The centre has **40 project teams** , 32 of which operate jointly with Paris-Saclay University and the Institut Polytechnique de Paris; Its activities occupy over 600 people, scientists and research and innovation support staff, including 44 different nationalities.

Context

This postdoctoral position is part of the **3DS-INRIA MediTwin** project, aimed at developing a preoperative surgical planning tool to support medical teams in managing single ventricle patients.

Once the surgical procedure is determined by the 3DS preoperative planning tool, the goal is to provide a simplified digital twin (0D model or other reduced model) that incorporates morphological changes from the planning tool as well as patient-specific functional data (e.g., from pulse wave Doppler ultrasound). This 0D digital twin can be calibrated using either a high-fidelity 3D digital twin or direct patient data, ultimately enabling postoperative outcome prediction and improved therapeutic decision-making.

The postdoctoral researcher will join the multidisciplinary and international **Simbiotx** Inria research team (https://team.inria.fr/simbiotx/) and will closely collaborate with cardiopediatric teams at 3DS, the Inria Commedia team for high-fidelity models, and the Necker-Enfants Malades Hospital.

Assignment

Mission : The mission is to develop and validate a 0D numerical model of blood circulation in single ventricle patients, integrating anatomical and functional changes determined by preoperative planning. The researcher will have to implement techniques for sensitivity analysis, identifiability, quantification of uncertainties, as well as data assimilation methods (including the use of Kalman filters) in order to personalize the digital twin to each patient and make it a reliable tool for clinical decision support. This work will also involve regular interaction with multidisciplinary teams (clinicians, engineers, researchers) and dissemination of results to the scientific and medical community.

Collaboration:
The candidate will interact with the clinical and scientific teams involved in the MediTwin project.

Responsibilities: The person recruited will be responsible for representing the team within the MediTwin project and will take initiatives for collaboration with the various groups.

Main activities

Main activities:

- Develop and validate 0D numerical models of blood circulation in HLHS patients (see [Migliavacca et al., 2001]), partly derived from existing 3D models ([Pant et al., 2022]).
- Conduct sensitivity analyses, identifiability studies, inverse problem-solving, and uncertainty quantification.

- Deduce 0D models from 3D simulations.
- Collaborate closely with a multidisciplinary team of clinicians, researchers, and engineers.
- Integrate clinical data to personalize the digital twins.
- Participate in project meetings and contribute to scientific publications.

Additional Activities:

- Document code and numerical tests.
- Write scientific articles and project progress reports.
- Present results at conferences and to clinical partners.

References :

- Francesco Migliavacca, Giancarlo Pennati, Gabriele Dubini, Roberto Fumero, Riccardo Pietrabissa, Gonzalo
  Urcelay, Edward L Bove, Tain-Yen Hsia, and Marc R de Leval. Modeling of the norwood circulation: effects
  of shunt size, vascular resistances, and heart rate. American Journal of Physiology-Heart and Circulatory
  Physiology, 280(5):H2076–H2086, 2001.
- Sanjay Pant, Aleksander Sizarov, Angela Knepper, Ga¨etan Gossard, Alberto Noferi, Younes Boudjemline, and Irene Vignon-Clementel. Multiscale modelling of potts shunt as a potential palliative treatment for suprasystemic idiopathic pulmonary artery hypertension: a paediatric case study. Biomechanics andmodeling in mechanobiology, 21(2):471–511, 2022.

Skills

Technical skills:

- Excellent command of numerical modeling, particularly as applied to cardiovascular systems.
- Solid experience in sensitivity analysis, identifiability, inverse problems and uncertainty quantification.
- CFD background (a plus)
- Proficiency in Python and C++ programming languages.
- Knowledge of Git for version control (a plus).

Personal skills :

- Experience of multidisciplinary collaboration, ability to integrate diverse teams.
- Excellent oral and written communication skills.
- Ability to work independently while valuing teamwork.

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

2788 € gross/month

General Information

- **Theme/Domain :** Modeling and Control for Life Sciences
- **Town/city :** Palaiseau
- **Inria Center :** Centre Inria de Saclay
- **Starting date :** 2025-01-01
- **Duration of contract :** 2 years, 1 month
- **Deadline to apply :** 2025-04-30

Contacts

- **Inria Team :** SIMBIOTX
- **Recruiter :**
  Vignon Clementel Irene / Irene.Vignon-Clementel@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.

The keys to success

- Ph.D. in applied mathematics, modeling, bioengineering, fluid mechanics, biomedical engineering or a related field.
- Ideally, already have experience in hemodynamic modeling and/or machine learning (ML).
  Be open to multidisciplinary work, ready to interact with a variety of profiles and adapt to different scientific cultures.
- Strive for excellence, motivated by innovation and research quality.
- Demonstrate a strong interest in real-world applications, particularly in the healthcare field.

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.