Offer #2026-10472

Post-Doctoral Research Visit F/M Postdoc - Robust optimisation of bifurcation diagrams for flutter design

Contract type : Fixed-term contract

Level of qualifications required : PhD or equivalent

Fonction : Post-Doctoral Research Visit

About the research centre or Inria department

Created in 2008, the Inria Saclay Center is located at the heart of the Paris-Saclay scientific and technological excellence cluster, which alone accounts for 15% of French research. Serving the development of the Université Paris-Saclay and the Institut Polytechnique de Paris, the Inria Saclay center employs 80 people in research support services and 500 scientists of 54 nationalities.

Benefiting from continuous growth, the center now has a total of 42 project-teams and two in the process of being created, including 21 jointly with the Institut Polytechnique de Paris, 16 with the Université Paris-Saclay, as well as 7 Inria EPs, including one in collaboration with Onera and one with the Pôle Universitaire Centre Val de Loire. These research teams are spread over more than ten sites.

Context

Supervised by:

- E. Denimal Goy and Pietro M. Congedo at Inria Saclay, PLATON Inria project-team; Center for Applied Mathematics (Ecole Polytechnique)
- B. Chouvion at Ecole de l'Air et de l'Espace; CREA

General details:

- Duration: 18 months
- Starting date: no later than January 2027
- Location: Inria Saclay, 1 rue Honoré d'Estienne d'Orves, 91120 Palaiseau, FRANCE
- Salary: gross monthly salary of about 2700€
- Funding: ANR FlexHALE, consortium of several French labs

Assignment

Project description and objectives

The optimisation and the design of the dynamic behaviour of mechanical structures play a key role in many industries to meet stringent environmental and performance requirements. The consideration of the non-linearities in such structures is essential. These non-linearities are at the origin of numerous and complex behaviours such as the softening or stiffening of the resonance peak, the existence of multiple dynamic solutions and the appearance of bifurcations in the dynamic behaviour. Bifurcations represent a stability limit in the parameter space characterised by a qualitative and quantitative change in the dynamics of the system (e.g. number and type of responses).

For example, in the development of HALE (High Altitude Long Endurance) or HAPS (High Altitude Pseudo-Satelite) drones, such as the HELIOS drone developed by NASA, the control of aeroelastic instability phenomena is a major challenge. Among these, aeroelastic flutter—resulting from the coupling between structural dynamics and aerodynamic forces—can lead to severe structural failures if not predicted with sufficient accuracy. Classic methods for predicting the critical flutter speed typically rely on deterministic models [5], whereas in practice, numerous sources of uncertainty exist, particularly related to aerodynamic properties, structural mechanical characteristics, or operational conditions. Explicitly accounting for these uncertainties is therefore crucial to identify reliable and robust designs [6].

Recent works from the team have focused on the deterministic optimisation of mechanical structures to reach desired bifurcation behaviours [1,2]. However, numerous uncertainties are present, either from the aerodynamic properties or from mechanical properties. The impact of those uncertainties is critical as the system stability can be impacted [3,4]. Their consideration from the structural optimisation is crucial to ensure the robustness and reliability of the mechanical design.

The objective of the postdoc is to develop robust optimisation methods for bifurcation diagrams. The aim is to combine technics for the analysis of bifurcation of optimization and of uncertainty quantification. Large parametric variations will be considered in the optimisation, leading to large structural variations and so a large range of dynamic behaviours. The bifurcation analysis as well as uncertainty propagation steps are numerically expensive and surrogate-based strategies will be investigated in order to reduce the numerical cost. Three main objectives have been identified for the postdoc:

- The development of the uncertainty propagation methods for the caracterisation of bifurcation behaviour of stochastic nonlinear dynamic systems,
- The development of robust optimisation methods for bifurcation diagrams,
- The development of methods able to deal with real-world scenarios, and more particularly on the test case of a HALE drone for flutter mitigation.

The person recruited will have to numerically implement, test and compare the different identified approaches developed during the postdoc.

Supervision

The postdoc will be supervised by E. Denimal Goy and P.M. Congedo, experts in uncertainty quantification methods for engineering applications. He/She will be also supervised by B. Chouvion from CREA/Ecole de l'Air et de l'Espace, where he has developed a physical solver for flutter calculation and characterization for mechanical structures with geometric nonlinearities and aerodynamic coupling.

The work will be conducted in the Platon team, a joint research group between Ecole Polytechnique and CNRS, hosted by the Center for Applied Mathematics (CMAP) of École Polytechnique. The Platon project-team focuses on developing innovative methods and algorithms for uncertainty management in numerical models, including advanced calibration strategies from data (observations, measurements, other model predictions) and uncertainty reduction.

Biblio:

[1] A. Mélot, E. Denimal, L. Renson, *Multi-parametric optimization of bifurcation structures*, Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences, 2024, 480:2023050520230505

[2] A. Mélot, E. Denimal Goy, L. Renson, *Control of isolated response curves through optimization of codimension-1 singularities*, Computers & Structures, 2024, 299: 107394.

[3] E. Denimal, J-J. Sinou, *Efficient parametric study of a stochastic airfoil system based on hybrid surrogate modelling with advanced automatic kriging construction*, European Journal of Mechanics-A/Solids, 2023, 99: 104926

[4] E. Denimal, J-J. Sinou, S. Nacivet, *Influence of structural modifications of automotive brake systems for squeal events with kriging meta-modelling method*, Journal of Sound and Vibration, 2019, 463: 114938

[5] R. Alcorta, B. Chouvion, G. Michon, O. Montagnier, *On the use of frictional dampers for flutter mitigation of a highly flexible wing*, International Journal of Non-Linear Mechanics, 2023, 156 :104515.

[6] N. Razaaly, N., B. Chouvion, *Quantile-Based Reliability-Constrained Optimization of a Nonlinear Absorber for Passive Aeroelastic Control under Aleatory Uncertainty*, Structural and Multidisciplinary Optimization, 2026.

Main activities

Main activities:

- Literature review
- Development of robust optimisation techniques for bifurcation diagrams
- Implementation of associated algorithms and validation on different test cases
- Writting documentation, reports and journal articles
- Prsentation (work progress meetings, team meetings, ANR consortiums meetings, conferences)

Skills

Candidates must hold a PhD in mechanical engineering, applied mathematics or a related discipline with background in at least one of these fields: non-linear dynamics, uncertainty quantification, robust optimisation or related fields. In particular, candidates must be proficient scientific computing, using langages such as Python or Matlab.

Applicants should submit a detailed academic CV with history of scientific production, evaluation documents of their PhD if available and a cover letter detailing the knowledge, skills and experience you think make you the right candidate for the job.
For further details, please contact E. Denimal Goy (enora.denimal-goy [at] inria.fr) and B. Chouvion (benjamin.chouvion [at] ecole-air.fr).

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

Remuneration

2788€ gross/month

General Information

- **Theme/Domain :** Numerical schemes and simulations
- **Town/city :** Palaiseau
- **Inria Center :** Centre Inria de Saclay
- **Starting date :** 2026-12-01

- **Duration of contract :** 1 year, 6 months
- **Deadline to apply :** 2026-11-30

Contacts

- **Inria Team :** PLATON
- **Recruiter :**
  Denimal Goy Enora / enora.denimal-goy@inria.fr

About Inria

Inria, the French national institute for research in digital science and technology, supports the French government in national research and innovation strategies in the digital field, acting as Digital Programs Agency. Inria leads over 300 research and innovation projects with its 3,500 scientists, engineers, and support staff, in partnership with universities and the digital ecosystem (businesses, entrepreneurs, and public stakeholders). Together, we explore strategic fields such as artificial intelligence, cybersecurity, quantum computing, cloud technologies, digital transformation in healthcare, digital twins, and digital technologies for defence. We develop practical solutions such as software, tech startups, partnerships with national companies, and cutting-edge training programmes. Our goal is to drive scientific, technological, and industrial excellence to ensure France’s digital sovereignty.

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.