



Offre n°2024-07200

Post-Doctoral Research Visit F/M Registration methods for shock-dominated flows

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

Type de contrat : CDD

Niveau de diplôme exigé : Thèse ou équivalent

Fonction : Post-Doctorant

Niveau d'expérience souhaité : Jeune diplômé

A propos du centre ou de la direction fonctionnelle

We aim at a step change in numerical modeling in order to answer actual industrial needs. Our goal is to implement these new models in performing codes on HPC infrastructures and to make them available to respond to societal needs. We do that by developing two fundamental enablers: reduced-order models and Cartesian grid methods. Thanks to these enablers it will be possible to transfer complexity handling from engineers to computers, providing fast, on-line numerical models for design and control.

Contexte et atouts du poste

In the framework of parametric model reduction, registration is the process of finding a bijection (or morphing) to align coherent structures of the solution in a reference configuration, over a range of parameters [2]. The problem is tightly linked to point-set registration in image processing, and shares relevant features with mesh morphing (r-adaptation) in scientific computing; nevertheless, registration for model reduction applications has several specificities that require innovative methodological solutions and motivate further research. First, in order to allow the correct enforcement of boundary conditions, the mapping should exactly preserve the boundary of the domain for all parameter values; second, the quality of the deformed mesh should be controlled; third, registration should rely on a moderate number of possibly low-fidelity snapshots to reduce the offline costs.

The objective of the exploratory action AM2OR (www.inria.fr/en/am2or) is to combine mesh adaptation, registration, and model order reduction to devise cost-efficient reduced-order models for parametric advection-dominated systems. In this respect, the importance of registration is twofold: first, to contribute to find a low-rank nonlinear representation of the solution field over a range of parameters; second, to facilitate the task of building a common mesh for all elements of the solution set. The recent publication [1] illustrates an integrated procedure to adaptively build the mesh, the parametric mapping, and the reduced-order model for two-dimensional conservation laws.

Keywords: model order reduction; registration methods; mesh morphing.

Mission confiée

The aim of the postdoctoral project is to develop and analyze a registration technique for general three-dimensional geometries, and to integrate the method in the integrated framework of [1]. To meet this goal, we identify two research tracks :

- Definition of general approximation spaces for diffeomorphisms in bounded domains. We plan to extend the method in [3] to three-dimensional geometries: we wish to find an ansatz which enables the rigorous enforcement of the bijectivity constraint for a broad class of Lipschitz domains of interest in engineering and to investigate the approximation properties in the space of diffeomorphisms.
- Development of a computational framework for registration. We plan to develop a general simulation framework to solve registration problems. This task encompasses numerical optimization, mesh morphing and generation techniques, and nonlinear model reduction.

Time permitting, we also envision the integration of the registration procedure in the mesh adaptation/model reduction framework proposed in [1].

References

[1] NICOLAS BARRAL, TOMMASO TADDEI, AND ISHAK TIFOUTI, Registration-based model reduction of parameterized PDEs with spatio-parameter adaptivity, *Journal of Computational Physics*, vol. 499, 2024.

[2] TOMMASO TADDEI, A registration method for model order reduction: data compression and geometry

reduction, SIAM Journal on Scientific Computing, vol. 42(2), 2020.

[3] TOMMASO TADDEI, Compositional maps for registration in complex geometries, submitted in 2023.

Principales activités

- Define a general approximation spaces for diffeomorphisms in bounded domains.
- Develop a computational framework for registration.
- Implement 3D test cases to demonstrate the method.
- (Integrate the procedure in the proposed mesh adaptation/model reduction framework.)

Additional activities :

- Publications (journal articles, conference presentations)
- Participation to meetings
- (Co-)supervision (masters students)

Compétences

The candidate should have a strong background in numerical methods for PDEs.

Background in

- (i) finite element/finite volume programming in C/C++,
- (ii) mathematical optimization, and
- (iii) computational differential geometry will be highly valued.

Avantages

- Subsidized meals
- Partial reimbursement of public transport costs
- 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

Informations générales

- **Thème/Domaine** : Schémas et simulations numériques
Calcul Scientifique (BAP E)
- **Ville** : Talence
- **Centre Inria** : [Centre Inria de l'université de Bordeaux](#)
- **Date de prise de fonction souhaitée** : 2024-05-01
- **Durée de contrat** : 2 ans
- **Date limite pour postuler** : 2024-05-31

Contacts

- **Équipe Inria** : [MEMPHIS](#)
- **Recruteur** :
Taddei Tommaso / tommaso.taddei@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.

L'essentiel pour réussir

We are looking for a motivated and ambitious candidate, ready to work in a truly international environment and in a team involving collaborators from different horizons (applied math, engineering,

computer science).

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

Thank you to send:

- CV
- Cover letter
- Support letters (mandatory)
- List of publication

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.