Offre n°2024-07965

Post-Doctoral Research Visit F/M Mesh adaptation for nonlinear dispersive wave propagation

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

Type de contrat : CDD

Niveau de diplôme exigé : Thèse ou équivalent

Fonction : Post-Doctorant

A propos du centre ou de la direction fonctionnelle

The Inria center at the University of Bordeaux is one of the nine Inria centers in France and has about twenty research teams.. The Inria centre is a major and recognized player in the field of digital sciences. It is at the heart of a rich R&D and innovation ecosystem: highly innovative SMEs, large industrial groups, competitiveness clusters, research and higher education players, laboratories of excellence, technological research institute...

Contexte et atouts du poste

Natural hazards like earthquakes, volcanoes, landslides, and tsunamis pose unpredictable risks with significant social and economic impacts. They are unpredictable and the submarine environment makes direct measurements extremely difficult. In this context, numerical simulations constrained with high quality geological data provide the unique tool to propose efficient risk reduction strategies. Disasters, like the Sumatra tsunami in 2004, the Tohoku tsunami in 2011, the Anak Krakatau volcano tsunami in 2018 or even the very recent Hunga tsunami, are reminders that such phenomena still need to be studied to reinforce our risk reduction strategies by innovative predictive models.

The goal of this project is the design and implementation of numerical schemes that will deal efficient with the different spatial scales during the propagation and inundation phases of the tsunamis.

Mission confiée

Starting from the tsunamis free surface water displacement and flow velocity fields which will be known, we will consider using the Boussinesq model UHAINA for simulating propagation and inundation phases. UHAINA [1], is an operational hydrodynamic model, combining high-order solutions (mandatory for a correct representation of dispersion), unstructured meshes and a HPC-devoted programming environment able to deal with the requirement of a real area. UHAINA also offers rapid development capabilities to integrate new approaches (mesh adaptation and embedded approach, see hereafter) to improve tsunami simulation. Static meshes, despite being refined a-priori around the coastline, are inherently not efficient for tsunami simulations where an impulsive wave is initially concentrated in a narrow region and then propagates over a certain distance. Mesh adaptation techniques have proved their efficiency in improving numerical accuracy while reducing the overall computational cost in many scientific domains. Several adaptive strategies have already been deployed for shallow water flows, including tsunami applications: hierarchical mesh refinement [3,4], unstructured re-meshing [3,5] and r-adaptation [6]. In contrast with [6], where the mesh vertices were moved but the connectivity remained fixed, we will investigate metric-based mesh adaptation, where the domain is entirely remeshed in order to optimize both the elements size and orientation. This allows us to change the global number of vertices throughout the simulation when the waves are expanding in the domain. Vertices can be moved between two remeshings to fine tune their location if needed. This sub-task will involve the coupling of the MMG remeshing software with UHAINA. Mesh adaptation full capabilities can only be leveraged when trying to generate the best possible mesh for a

given computation: mesh adaptation is then seen as a process to minimize a certain well-chosen error. Driven by this minimization, one expects the simulations to be noticeably more accurate, and even to emphasize flow details usually neglected by standard refinement procedures. The error model is thus key in the adaptation process. We will first evaluate the performance of classic interpolation error based on indicators developed in the continuous mesh framework [2]. However, the dispersive regularization of the SWE results in more regular solutions, for which classic error models may be limited. A key point of the project will be to propose error estimators well suited for non-linear dispersive wave propagation. To our best knowledge, such an error model would be completely novel. In particular, local smoothness of the solution will first be considered, then we will study phase errors and ways to control them. We have to highlight that, up to the authors' knowledge, mesh adaptation for dispersive wave propagation is, up to now, only limited on structured meshes [4,7] and this will be the first time unstructured meshes will be used. Once the adaptive process has been validated on academic test cases, we will run large scale simulations of tsunamis in a realistic setting.

[1] Filippini, A.G., et al., 2018, UHAINA, XVèmes Journés Nationales Génie Côtier - Génie Civil, DOI:10.5150/jngcgc.2018.006.

[2] Barral, N., Olivier, G., Alauzet, F., 2017. Time-accurate anisotropic mesh adaptation for three-dimensional time-dependent problems with body-fitted moving geometries. *J. Comput. Phys.*, 331, 157-187.

[3]- Wallwork, J. G., Barral, N., Kramer, S., Ham, D., Piggott, M., 2020. Goal-oriented error estimation and mesh adaptation for shallow water modelling. *SN Applied Sciences*, Springer Verlag, 2-6.

[4]- Berger, M.J., & LeVeque, R. J.,Implicit adaptive mesh refinement for dispersive tsunami propagation, https://arxiv.org/pdf/2307.05816

[5] Blaise, S. & St-Cyr. A., A dynamic hp-adaptive discontinuous Galerkin method for shallow water flows on the sphere with application to a global tsunami simulation. *Mon. Weather Rev.*, 140(3):978--996, 2012.

[6] - Arpaia, L., & Ricchiuto, M., 2020. Well balanced residual distribution for the ALE spherical shallow water equations on moving adaptive meshes. *J. Comput. Phys.*, 405, 109173.

[7] Popinet, S., 2015. A quadtree-adaptive multigrid solver for the Serre–Green–Naghdi equations.*J Comput. Phys*., 302,336-358

Principales activités

- Coupling of MMG with the code UHAINA.
- Evaluation of the performance classic interpolation error.
- Propose new error estimators for non-linear dispersive wave propagation.
- Run large scale simulations of tsunamis in a realistic setting.

Compétences

Technical skills and level required :

Languages :

Relational skills :

Other valued appreciated :

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

The gross monthly salary will be 2788€ (before social security contributions and monthly witholding tax).

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 :** 2024-11-01
- **Durée de contrat :** 2 ans
- **Date limite pour postuler :** 2024-08-31

Contacts

- **Équipe Inria :** CARDAMOM
- **Recruteur :**
  Kazolea Maria / maria.kazolea@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

There you can provide a "broad outline" of the collaborator you are looking for what you consider to be necessary and sufficient, and which may combine :

- tastes and appetencies,
- area of excellence,
- personality or character traits,
- cross-disciplinary knowledge and expertise...

This section enables the more formal list of skills to be completed and 'lightened' (reduced) :

- "Essential qualities in order to fulfil this assignment are feeling at ease in an environment of scientific dynamics and wanting to learn and listen."
- " Passionate about innovation, with expertise in Ruby on Rails development and strong influencing skills. A thesis in the field of **** is a real asset."

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

If you are interested by this job, please could you apply on website jobs.inria with the following documents :
-cv
-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.