A propos du centre ou de la direction fonctionnelle

Created to apply recent advances in three-dimensional scientific computing to different areas in geophysics, and particular seismic wave propagation, Magique-3D is a joint project-team between Inria and the Department of Applied Mathematics (LMA) of the University of Pau, in partnership with CNRS.

The mission of Magique-3D is to develop and validate efficient solution methodologies for solving complex three-dimensional geophysical problems, with a particular emphasis on problems arising in seismic imaging, in response to the local industrial and community needs. Indeed, as it is well known, the region of Pau has long-standing tradition in the Geosciences activities.

Contexte et atouts du poste

This PhD project is part of a program that we develop on the numerical solution of wave problems in very large domains with numerous source terms. The propagation domain may be for instance a local region of the interior of the Earth affected by an earthquake. More generally, it can be any piece of complex medium like carbonates which correspond to the most heterogeneous porous media. Carbonate reservoirs are of great interest because they might provide natural areas for storing carbon dioxide. Regarding numerics, it is a challenging problem, in particular because it requires a huge computational power which needs a proper utilization to avoid reaching the limits of the computing capacities. Regarding the approach of research, the main keys words arise quite naturally: high orders, approximation and hp-adaptivity for accuracy and efficiency, discontinuous finite elements for parallelization, fast time integration for limiting the computational duration and simplicity for reducing the memory storage and also making the computations faster. In a recent PhD thesis [1], we have addressed all these features by proposing to develop a Trefftz approximation of transient wave problems involving discontinuous basis functions. Trefftz-DG solution methodologies are now popular and their implementation has mainly been done in the time-harmonic domain. Very few papers have been devoted to the case of transient wave problems and, to the best of our knowledge, the only deal with the case of acoustic and electromagnetic waves with some numerical experiments in 1D+time dimensions. The team has then developed a 2D numerical solver which has been used to access the potential of Trefftz-DG formulations based on DG technologies for solving wave problems. The formulation of the problem includes a Tent Pitcher algorithm which consists in constructing the numerical solution by following the wave fronts. It results in covering the space-time domain by tent-like elements respecting the propagation cone inherited from the finite propagation speed principle. We have obtained preliminary results showing very promising simulations in 2D. Now the optimization and the parallelization of the code is required and general boundary conditions must also be implemented in order to test the software adapt to geophysical problems involving regional computations. It is worth noting that the computer science community shows a very strong interest in space-time discretizations due to the development of new computers.

Mission confiée

In order to address realistic problems, we now need to couple our Trefftz-Tent Pitching code with 2D-space and 3D+time structures. To this end, the report [2] providing a 40 parallel mesh generator deserves a particular attention. As we are building a space-time discretization methodology we would like to consider parallelization in time and we would like to apply the ideas recently developed in [3], where the parallelization is based on the diagonalization of the time stepping matrix proposed in [4]. We also have to consider the implementation of more complex boundary conditions. Until now, we have restricted ourselves to the case of Dirichlet boundary condition which does not involve any differential operator. This kind of conditions are thus well-suited to Trefftz formulations, where the variational formulation does not contain differential operators. We now wish to address the case of high-order absorbing boundary conditions requiring the introduction of high-order differential operators in the formulation. Since Trefftz method involves solutions to the wave equation, it is possible to write the solution as the sum of in-coming and out-going waves, especially when using space-time meshes. It should thus be possible to cancel the in-coming field and to design naturally Absorbing Boundary Conditions that are crucial to model wave propagation in very large domains.

This PhD project fits into a larger program dealing with the simulation of waves in complex media and for which we also have experimental activities providing us with data. The PhD student will thus have the opportunity of collaborating with PhD students working on measures of waves into a laboratory. The targeted application is the understanding of waves including acoustic and elastic waves into complex media. The piece of software that will be developed should then be used for characterizing complex media by using quantitative inversion methods.

- M. Gander, L. Halpern, J. Raynaud, and J. Ryan. A direct time parallel solver by diagonalization for the wave equation. 2017

Informations générales

- Thème/Domaine : Sciences de la planète, de l'environnement et de l'énergie
- Calcul Scientifique (BAP E)
- Ville : Pau
- Centre Inria : CRI Bordeaux - Sud-Ouest
- Date de prise de fonction souhaitée : 2019-10-01
- Durée de contrat : 3 ans
- Date limite pour postuler : 2019-04-14

Contacts

- Equipe Inria: MAGIQUE-3D
- Directeur de thèse : Diaz Julien/julien.diaz@inria.fr

A propos d'Inria

Inria, l'institut national de recherche dédié aux sciences du numérique, promeut l'excellence scientifique et le transfert pour avoir le plus grand impact. Il emploie 2400 personnes. Ses 200 équipes-projets agiles, en général communes avec des partenaires académiques, impliquent plus de 3000 scientifiques pour relever les défis des sciences informatiques et mathématiques, souvent à l'interface d'autres disciplines. Inria travaille avec de nombreuses entreprises et a accompagné la création de plus de 160 start-up. L'institut s'efforce ainsi de contribuer aux enjeux de la transformation numérique de la science, de la société et de l'économie.

L'essentiel pour réussir

This project requires:
1) a good knowledge of hyperbolic problems including their mathematical properties and their numerical approximation
2) an experience in finite element methods programming
3) an experience in parallel computing (MPI, OpenMP)

Ideal background: Master in applied mathematics with a clear interest in numerical analysis and programming

Consignes pour postuler

Thank you to send:
- CV
- Master marks and ranking
- Support letter(s)

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.
Avantages
- Subsidized meals
- Partial reimbursement of public transport costs
- 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
- Social security coverage

Rémunération
1982€ / month (before taxes) during the first 2 years, 2085€ / month (before taxes) during the third year.