Offre n°2023-06381

PhD Position F/M Fast solvers for studying light absorption by nanostructured imagers

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

Type de contrat : CDD

Niveau de diplôme exigé : Bac + 5 ou équivalent

Autre diplôme apprécié : Master in applied mathematics or scientific computing

Fonction : Doctorant

Niveau d'expérience souhaité : De 3 à 5 ans

A propos du centre ou de la direction fonctionnelle

The Inria centre at Université Côte d'Azur includes 37 research teams and 8 support services. The centre's staff (about 500 people) is made up of scientists of different nationalities, engineers, technicians and administrative staff. The teams are mainly located on the university campuses of Sophia Antipolis and Nice as well as Montpellier, in close collaboration with research and higher education laboratories and establishments (Université Côte d'Azur, CNRS, INRAE, INSERM ...), but also with the regiona economic players.

With a presence in the fields of computational neuroscience and biology, data science and modeling, software engineering and certification, as well as collaborative robotics, the Inria Centre at Université Côte d'Azur is a major player in terms of scientific excellence through its results and collaborations at both European and international levels.

Contexte et atouts du poste

The exploitation of nanostructuring in order to improve the performance of CMOS imagers based on microlens grids is a very promising avenue. In this perspective, numerical modeling is a key component to accurately characterize and optimize the absorption properties of these complex imaging structures which are intrinsically multiscale (from the micrometer scale of the lenses to the nanometric characteristics of the nanostructured material layers). The present PhD project is proposed in the context of a collaboration between the Atlantis project-team of Inria research center at Université Côte d'Azur and STMicrolectronics (CMOS Imagers division of the Technology for Optical Sensors department) in Crolles. A Cifre funding will support this project.

The objectives of the project are to design (1) a fast electromagnetic simulation approach based on a model reduction technique, to characterize numerically the light trapping in digital imagers exploiting nanostructured pixels and, (2) a multi-objective optimization strategy of the geometrical characteristics of the nanostructuring in order to simultaneously maximize the light absorption in a pixel and to minimize the crosstalk phenomenon between neighboring pixels. For the first time, in addition to the rigorous methods for solving Maxwell's equations, we will be able to benefit from an alternative simulation approach based on model reduction. This new approach can be used in an optimization process and the expected gain in total computation time would be between 10 to 1000.

Mission confiée

Atlantis is a joint project-team between Inria and the Jean-Alexandre Dieudonné Mathematics Laboratory at Université Côte d'Azur. The team gathers applied mathematicians and computational scientists who are collaboratively undertaking research activities aiming at the design, analysis, development and application of innovative numerical methods for systems of partial differential equations (PDEs) modelling nanoscale light-matter interaction problems. In this context, the team is developing the DIOGENeS [https://diogenes.inria.fr/] software suite, which implements several Discontinuous Galerkin (DG) type methods tailored to the systems of time- and frequency-domain Maxwell equations possibly coupled to differential equations modeling the behaviour of propagation media at optical frequencies. DIOGENeS is a unique numerical framework leveraging the capabilities of DG techniques for the simulation of multiscale problems relevant tonanophotonics and nanoplasmonics.

The core of the present study is concerned with reduced-order modeling for time-domain electromagnetic wave propagation problems. In short, reduced-order models (ROMs) are simplifications of high fidelity, complex models. They capture the behavior of these source models so that one can quickly study a system's dominant effects using minimal computational resources. The starting point

will consist on some preliminary works and contributions that the team has obtained during the recent years by considering a particular reduced-order modelling technique known as the proper orthogonal decomposition (POD) method.

In the POD approach, a reduced subspace with a significantly smaller dimension is constructed by a set of basis vectors extracted offline from snapshots that are extracted from simulations with a high order DGTD method. By doing so, a non-intrusive POD-based ROM has been developed for the solution of parameterized time-domain electromagnetic scattering problems. The considered parameters are the electric permittivity and the temporal variable. By using the singular value decomposition (SVD) method, the principal components of the projection coefficient matrices (also referred to as the reduced coefficient matrices) of full-order solutions onto the RB subspace are extracted. A cubic spline interpolation-based (CSI) approach is proposed to approximate the dominating time- and parameter-modes of the reduced coefficient matrices without resorting to Galerkin projection. The generation of snapshot vectors, the construction of POD basis functions and the approximation of reduced coefficient matrices based on the CSI method are completed during the offline stage. The RB solutions for new time and parameter values can be rapidly recovered via outputs from the interpolation models in the online stage. In particular, the offline and online stages of the proposed RB method, termed as the POD-CSI method, are completely decoupled, which ensures the computational validity of the method. Starting from these previous contributions, the present study will aim at two objectives: one one hand, the efficiency improvement, as well as the development of the proposed non-intrusive ROM methodology for three-dimensional (3d) parameterized time-domain electromagnetic scattering problems; on the other hand, the study of possible strategies for dealing with geometrical parameters.

Moreover, the recruited PhD student will also be exposed to alternative physics-based alternative numerical modeling in the framework of modal approaches developed at STMicroelectronics. These modal type methods are part of the reference simulation methods routinely in this industrial context.

Principales activités

- Bibliography study on data-driven ROM
- Analysis of our previous works
- Getting started with existing Python codes for the POD-CSI method in the 2d case
- Specification and development (in Fortran 2003 and Python) of a POD-CSI software for 3d problems
- Adaptation of the 3d POD-CSI software to high performance computing systems
- Extension of the existing POD-CSI approach for handling geometrical parameters
- Detailed assessment of the novel ROM methdologies by considering practical scattering problems
- Writing of scientific publications

Compétences

Technical skills and level required :

- Master or engineering degree in numerical mathematics or scientific computing
- Sound knowledge of numerical analysis for PDEs
- Basic knowledge of physiscs of electromagnetic wave propagation

Software development skills : Python and Fortran 2003, parallel programming with MPI and OpenMP

Relational skills : team worker (verbal communication, active listening, motivation and commitment)

Other valued appreciated : good level of spoken and written english

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
- Contribution to mutual insurance (subject to conditions)

Rémunération

Duration: 36 months

Location: Sophia Antipolis, France

Gross Salary per month: 2051€ brut per month (year 1 & 2) and 2158€ brut per month (year 3)

Informations générales

- **Thème/Domaine :** Schémas et simulations numériques
  Calcul Scientifique (BAP E)
- **Ville :** Sophia Antipolis
- **Centre Inria :** Centre Inria d'Université Côte d'Azur
- **Date de prise de fonction souhaitée :** 2023-10-02
- **Durée de contrat :** 3 ans
- **Date limite pour postuler :** 2024-06-30

Contacts

- **Équipe Inria :** ATLANTIS
- **Directeur de thèse :**
  Lanteri Stéphane / Stephane.Lanteri@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.

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

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.