Offre n°2023-05862

PhD Position F/M Designing highly efficient ultrafast dynamical metasurface for LIDAR applications

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

Type de contrat : CDD
Niveau de diplôme exigé : Bac + 5 ou équivalent
Fonction : Doctorant
Niveau d'expérience souhaité : De 3 à 5 ans

A propos du centre ou de la direction fonctionnelle

Inria is a national research institute dedicated to digital sciences that promotes scientific excellence and transfer. Inria employs 2,400 collaborators organised in research project teams, usually in collaboration with its academic partners. This agility allows its scientists, from the best universities in the world, to meet the challenges of computer science and mathematics, either through multidisciplinarity or with industrial partners. A precursor to the creation of Deep Tech companies, Inria has also supported the creation of more than 150 start-ups from its research teams. Inria effectively faces the challenges of the digital transformation of science, society and the economy.

Contexte et atouts du poste

The present postdoctoral project is part of a collaborative project between the Atlantis project-team from the Inria Research Center at Université Côte d'Azur, (2) CRHEA in Sophia Antipolis, France, and (3) LAAS in Toulouse France.

Atlantis is a joint project-team between Inria and the Jean-Alexandre Dieudonné Mathematics Laboratory at Université Côte d'Azur. The team gathers 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 to nanophotonics and nanoplasmonics.

Mission confiée

Metasurfaces are engineered materials that can precisely control the behavior of electromagnetic waves by using subwavelength-sized elements called meta-atoms. These meta-atoms can be designed to exhibit specific electromagnetic responses, which allows metasurfaces to manipulate the properties of light waves in a highly controlled manner. Metasurfaces can be divided into two main categories: passive and active. Passive metasurfaces have a fixed response to incident electromagnetic waves, meaning that their functionality is set during fabrication and their geometrical parameters are tuned to achieve the desired response. Active metasurfaces, on the other hand, can actively change their response in real-time by incorporating active materials such as phase change materials, liquid crystals, or materials with electro-optical response. This allows for dynamic manipulation of light waves upon the application of external stimuli, achieved by spatially modulating the permittivity of the nano-resonators. However, designing efficient active metasurfaces is challenging because the refractive index modulation response is often not sufficient to achieve the necessary conditions for wavefront control, especially for materials with ultrafast response. This usually requires a deep understanding of the topological resonance behavior and careful numerical modeling to achieve full phase modulation with high amplitude response in a single unit-cell configuration.

The main goal of this PhD project is to use numerical methods to optimize the design of active nanostructures in order to achieve the highest possible phase modulation and amplitude response. The optimization process will focus on adjusting the dimensions and shapes of meta-atoms and will take into account the limitations of the active materials used. For passive metasurfaces, different resonators with different shapes are used to achieve the desired phase profile, but in an active system, all resonators in a microcell will have the same shape but will be modulated differently by applying different voltages. As a result, a more advanced optimization method is needed to account for the effects of near-field...
The second perspective objective is to design metasurface configuration achieving the ultrafast light modulation, in the order of a fraction of the optical frequency. This offers exceptional peculiar perspective applications in particular with the emerging innovative space-time metasurfaces modulations [EL22, ST22]. In the present Ph.D. project, we aim at first developing the appropriate modeling tools for solving Maxwell’s equations with space-time material variations relying on advanced high-order methods. Besides, we aim at deploying the advanced tools and benefiting from our experience in the field of metasurface [MELS19, MELS21, MELS22, MELS23] for optimizing spatiotemporal metasurfaces at optical and NIR regimes and achieve exceptional and exotic functionalities at the optical frequency speed.

This study will exploit a numerical methodology that has previously been used successfully for passive cases [MELS19, MELS21]. This method consists of two components: a global optimization method based on statistical learning for the outer loop, and a fullwave solver for the inner loop to accurately evaluate a given design. The outer loop, which is driven by the Efficient Global Optimization (EGO) method, explores the predefined design space in an efficient manner to minimize the number of calls to the fullwave solver. The inner loop relies on the Discontinuous Galerkin Time-Domain (DGTD) method, which combines high order discontinuous finite elements for space discretization with an explicit time-stepping method for time integration of the 3D time-domain Maxwell equations. The DGTD method [Viq15] is accurate, efficient and easy to implement.


Ville : Sophia Antipolis  
Centre Inria : Centre Inria d'Université Côte d'Azur  
Date de prise de fonction souhaitée : 2023-09-01  
Durée de contrat : 3 ans  
Date limite pour postuler : 2024-05-31

Contacts

- Équipe Inria : ATLANTIS  
  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.