PhD offer

At IETR (Institut d'électronique et des technologies du numérique) UMR CNRS 6164, France

ANALYSIS AND DESIGN OF PERIODIC STRUCTURES USING ARTIFICIAL INTELLIGENCE

Project context

Satellite communications and Earth observation systems are facing increasingly stringent performance requirements driven by the deployment of low Earth orbit (LEO) constellations and the growing need for accurate climate monitoring. These applications rely on advanced electromagnetic (EM) periodic structures, such as polarization converters, metasurfaces, and dichroic devices, to enable low-profile, lightweight, and low-cost hardware solutions that are compatible with mass production and space-borne constraints [1]-[2]. However, the analysis and design of these advanced EM devices involve highly parameterized geometries, strong electromagnetic coupling effects, and stringent performance trade-offs across wide frequency bands and incidence angles. This leads to a heavy reliance on computationally expensive full-wave simulations, resulting in long design cycles and limited exploration of the design space. In this context, artificial intelligence (AI) emerges as a promising solution [3]-[4]: by learning the complex relationships between structural parameters and EM responses, AI-based methods can drastically reduce computational cost and enable rapid optimization, paving the way for efficient development of next-generation, low-cost, and high-performance components for space communications and Earth observation systems.

[1] M. Ettorre, F. F. Manzillo, M. Casaletti, R. Sauleau, L. Le Coq, and N. Capet, "Continuous transverse stub array for Ka-band applications," *IEEE Trans. Antennas Propag.*, vol. 63, no. 11, pp. 4792–4800, Nov. 2015.

[2] C. Bilitos, X. Morvan, R. Sauleau, E. Martini, S. Maci and D. González-Ovejero, "Series dual-fed continuous transverse stub array with enhanced multibeam operation enabled by a reflective luneburg lens," *IEEE Trans. Antennas Propag.*, vol. 72, no. 11, pp. 8420-8432, Nov. 2024.

[3] A. Massa, G. Oliveri, M. Salucci, N. Anselmi, and P. Rocca, "Learning-by-examples techniques as applied to electromagnetics," *J. Electromag. Waves Appl.*, vol. 32, no. 4, pp. 516-541, 2018.

[4] M. Li and M. Salucci, *Applications of Deep Learning in Electromagnetics: Teaching Maxwell's equations to machines*. Scitech Publishing, 2023.

Objectives of the PhD offer

The main objective of this PhD project is to develop advanced methods for the analysis and design of EM periodic structures for polarization control and radiometric applications, by combining EM theory, periodic structures, and AI-based optimization techniques.

Work context

This thesis is part of the ongoing collaborative activities between IETR and the French space agency CNES (https://cnes.fr). This interdisciplinary project will be carried out at IETR – UMR CNRS 6164 (http://www.ietr.fr) and it will strongly involve two of IETR's technological platforms:

1) nR (NanoRennes) platform, https://www.ietr.fr/en/nr-nanorennes-platform with experience in microfabrication.
2) M²ARS (Manufacturing Measurement Analysis of Radiating Systems) platform https://www.ietr.fr/en/m2ars-manufacturing-measurement-analysis-radiating-systems-platform, with experience in advanced antenna metrology and prototyping.

The PhD student will conduct a literature review on AI tools and on the analysis and synthesis of periodic structures to identify the most suitable AI-based optimization techniques for the design phase. This will be followed by the prototyping and experimental characterization of the resulting components, which will be fabricated and tested using IETR's world-class facilities.

Candidate

Required education level: Master or equivalent degree in electrical engineering or physics.
Duration: 36 months.
Required background: antenna theory, microwave engineering, antenna arrays, periodic structures. Proficiency in written and spoken English (knowledge of French is not required).

How to apply: The call for applications will be open **from February 2 to March 13, 2026**, on the CNES website https://recrutement.cnes.fr/fr/annonce/4132755-26-153-analysis-and-optimization-of-periodic-structures-using-ai-35700-rennes

To apply please use the link above to send your motivation letter, CV, and recommendation letters (optional) and send them by email to the contact persons (see below).

Contact persons:

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