PhD Position in Computational Design & Analysis of Engineering Metamaterials (VAC-2021-38)

Title of the PhD project: Computational design and optimization of wireless power transfer (WPT) metamaterials

INTRODUCTION:

The International Centre for Numerical Methods in Engineering (CIMNE, www.cimne.com) is a research centre, created in 1987 by consortium between the Catalan Government and the Universitat Politècnica de Catalunya (UPC-BarcelonaTech), devoted to the development and application of numerical methods to a wide range of areas in engineering. CIMNE has been selected as a Severo Ochoa Centre of Excellence for the period 2019-2023, the highest level of recognition of excellence and leadership awarded to a research centre in Spain.

POSITION DETAILS

Number of vacancies: 1
Category: PhD (PHD2)
Location: Barcelona
Yearly salary (gross): 17.563,14 EUR
Working hours: Full time
Duration: 3 years
Starting date: No later than Sept 2021

FUNCTIONS TO BE DEVELOPED BY THE APPLICANT

CIMNE is looking for a **PhD Researcher** to be part of the Research and Technical Development (RTD) Group on Computational Design & Analysis of Engineering Metamaterials.

The functions assigned to the candidate will be:

- Complete a PhD on Structural Engineering at Universitat Politècnica de Catalunya – Barcelona Tech. The candidate is expected to complete the PhD thesis in a maximum of three years.
- Collaborate with various research groups within CIMNE and worldwide.
- To publish a minimum of two papers in JCR journals during the PhD period, author and co-author articles in high-impact international journals
- Carry out quality research, training and management.
- Participate on the dissemination and outreach activities associated with the project
- Participate in international conferences presenting her/his work

DESCRIPTION OF THE PHD PROJECT:

Electrical energy is object of an increasing interest in the challenge of replacement of contaminating energies (fuel-based energies) by clean energies, especially in the automotive sector. The “Wireless Power Transfer” (WPT) term stands for the wireless” (through-air) transmission of electrical energy via two sequential energy-transform processes:

1) The emitted electric energy is transformed, via a specifically designed coil placed in the initial position, in a magnetic flow ruled by the classical Maxwell’s laws for electromagnetic induction,

2) This magnetic flow reaches a second, coil placed at a certain distance and position, that makes the inverse function: transforms the magnetic flow into electrical energy (the absorbed electrical energy). As a result, the electrical energy has been wirelessly transported, which, in addition, can be done dynamically (the two points can be moving from one another).

The challenge to be addressed is the enormous loss of efficiency (power losses) when the distance between the emitter and receiver points goes beyond a few centimeters, which precludes the use of WPT for many practical purposes [1]. The idea behind the proposed research is to contribute to solving the challenge of these losses by designing materials for coils [2], with unusual properties (electromagnetic meta-materials) to “amplify” the intensity of the magnetic flow by using architected multi-scale topology optimized coils, to exploit the phenomenon of “electromagnetic-resonance”. The phenomenon is somehow the “inverse” of the “acoustic resonance” one successfully used in the group for achieving high efficiency attenuating acoustic meta-materials [3].

The applications of this technology are multiple [1], e.g.., fast and efficient battery recharging (in service stations) by electrical cars positioned on fixed or moving WPT devices, selective dynamic exchange of electrical energy “donated” from fuel-powered cars to electrical cars” in roadways, among many others.

References

[1] Z. Zhang, B. Zhang, B. Deng, X. Wei, and J. Wang, “Opportunities and challenges of metamaterial-based wireless power transfer for electric vehicles,” Wirel. Power Transf., vol. 5, no. 1, pp. 9–19, Mar. 2018, doi: http://dx.doi.org/10.1017/wpt.2017.12.

[2]Y. Otomo and H. Igarashi, “A 3-D Topology Optimization of Magnetic Cores for Wireless Power Transfer Device,” IEEE Trans. Magn., vol. 55, no. 6, pp. 1–5, Jun. 2019, doi: http://dx.doi.org/10.1109/TMAG.2019.2900744.

[3] D. Roca, D. Yago, J. Cante, O. Lloberas-Valls, and J. Oliver, “Computational design of locally resonant acoustic metamaterials,” Comput. Methods Appl. Mech. Eng., vol. 345, pp. 161–182, Mar. 2019, doi: http://dx.doi.org/10.1016/j.cma.2018.10.037.

REQUIREMENTS

1. Master degree in Aeronautical, Civil, Mechanical, Electrical, Engineering, Physics, or similar.
2. Deep acquaintance with numerical modelling and simulation (computational mechanics)
3. Familiar with scientific coding languages (Matlab, Python, C++ etc…) and good abilities for scientific programming.

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4. Knowledge of English.

EVALUATION OF CANDIDATES

The requirements and merits will be evaluated with a maximum mark of 100 points. Such maximum mark will be obtained by adding up the points obtained in the following items:

- Academic record (60%)
- Previous research and academic experience in the field of the position (20%)
- Programming skills (10%)
- Language skills (10%)

HOW TO APPLY

Candidates must complete the "Application Form" form on our website, indicating the reference of the vacancy and attaching the following documents **in English**:

- Curriculum vitae
- A motivation letter
- Academic transcripts from all Undergraduate and MSc degrees
- Name and institutional contact information of two possible referees

The deadline for registration to the offer ends on 31st May, 2021 at 12 noon.

The shortlisted candidates may be called for an interview. They may also be required to provide further supporting documentation.

CIMNE is an equal opportunity employer committed to diversity and inclusion. We are pleased to consider all qualified applicants for employment without regard to race, colour, religion, sex, sexual orientation, gender identity, national origin, age, disability or any other basis protected by applicable state or local law. CIMNE has been awarded the HRS4R label.