OrbiMob' Academy: Digitalization and decarbonization of mobility

Thesis topic

Themes
- Mobility & Infrastructure
- Energy for mobility

Title: Dynamic power transfer by strong resonant magnetic coupling for dynamic electric vehicles.

Development of the subject
The range of electric vehicles is increasing year after year, but battery charging remains a sensitive subject. Current trends focused mainly on increasing the charging capacities of electric vehicle batteries in order to gain autonomy and compete with thermal vehicles. In our opinion, this race is illusory as demand is increasing and raw materials are becoming scarce.
Like the diet of human beings whose stomach generally occupies 2% of the total volume of the body, we believe that the weight of the battery should not exceed 10% of the weight of the vehicle to carry the just amount of necessary power. Then recharge regularly either statically at stopping points (tollbooths, traffic lights, parking lots, garages, etc.) or dynamically (sections of road or sections of highway).
The alternative solutions is "electric road" based on the magnetic resonance. The road of tomorrow will be capable of supplying electric vehicles wirelessly but could also be a strategical communication medium.
A doctoral thesis began on the subject on September 1, 2021 (end in 2024) with the aim of increasing skills on this risky but high-potential subject. Beyond the fundamental aspects of power transmission between distributed source and mobile receiver, the first results show very promising performances on a laboratory model produced (power of 4.6 kVA and a frequency ranging from 79 kHz to 90 kHz: range dedicated to electric vehicles).
The proposed thesis will therefore have the main objectives:
- consolidate the fundamental studies carried out with, in particular the optimization of the geometries of the inductors and the control of the state variables of the resonators for optimum and stable transfer. These performances must accommodate the different sensitivity elements (lateral, longitudinal and vertical positioning of the inductors in the vehicle and in the roadway).
- analyze the efficiency of the transfer depending on the inductors environment (roadway position, influence of the ground materials, etc.)
- optimize power continuity in dynamic mode: road segments of several meters long will carry out the inductors; they became active when the vehicle is present.
- validate the principles as much as possible on scale 1 setup.

Context elements
- Apart from the fact that this subject is naturally in line with the objectives of the "OrbiMob' Academy Digitalization and decarbonization of mobility" project, this subject fits perfectly into the themes of the CIR-ITPS focused on mobility (the CIR-ITPS also co-financed the first prototype).
- A regionalized I-DEMO project called "the inductive road" is in preparation for an application scheduled for October 29, 2024. This project, which plans a 2.2 km loop around the Cezeaux campus, aims to develop low-cost autonomous shuttles. Power of 6 kVA is transferred wirelessly and dynamically from the infrastructure to the electric vehicle.

Host laboratory
This thesis project will be developed within the PHOTON group (PHOTonics, Waves, and Nanomaterials) of the Pascal Institute (UMR 6602 of the CNRS), it brings together theorists and developers in the physics of materials, electromagnetism and electronics. The concerned topic is power electronics and electromagnetic compatibility.

Candidate profile
The candidate must have solid skills in power electronics, knowledge of electromagnetic compatibility, particularly wave-conductor coupling, and an appetite for experimentation.

Salary
The doctoral student will receive a gross monthly salary of €2,100.

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Application
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