Polytech network form for PhD Research Grants from the China Scholarship Council

This document describes the PhD subject and supervisor proposed by the French Polytech network of 14 university engineering schools. Please contact the PhD supervisor by email or Skype for further information regarding your application.

Supervisor information	
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Polytech name	Polytech Lille
University name	University of Lille
Country	France

PhD information	
Title	Numerical modeling and validation of a wireless charging structure applied to electric vehicles

Main topics regards to CSC list (3 topics at maximum)	Electrical engineering
Required skills in science and engineering	Electrical engineering, numerical modeling and simulation, device control

Subject description (two pages maximum)

Global context :

The transportation industry is currently facing major technological transformation. The fast depletion of fossil resources, as well as environmental concerns, lead to the industry to work on less environmentally impacting vehicles, such as electric and hybrid vehicles. The electrical charge of these vehicles is classically performed with regular cable connection (Fig. 1). Recent developments have improved the charging speed with 80% charging of the battery in less than half an hour. Nevertheless the drawbacks of cable connection still remain unchanged. The driver must manipulate the charging cable to be plugged into an electrical outlet. The cable must be regularly checked for maintenance and is also not convenient to handle: rigidity and dirt because of ground contact. To avoid these drawbacks a wireless charging (Fig. 2), based on the principle of transformer energy conversion, is an attractive and elegant alternative solution.

Fig. 1. Regular cable connection (http://jalopnik.com/)

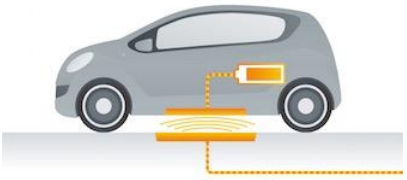

Fig. 2. Wireless charging (http://www.ipwatchdog.com/)

Nevertheless, the wireless charging implies a large distance, with an air gap, between the primary and secondary sides, which leads then to a weak coupling. Therefore, to obtain a significant power transfer, a high reactive power must be managed. The solution consists in placing resonant elements, on both primary and secondary sides, in order to compensate the reactive power and ensure good efficiency. In addition, the output parameters, at the load side, must be regulated in order to keep the charger operating at a given voltage with the current required by the battery. The control of the output parameters also allows the protection of the load.

Objectives :

The main objective of the thesis is to compare different topologies in terms of performances of the magnetic circuit in wireless charging structures. This study will be performed through a numerical approach by investigating the effects of different magnetic materials, misalignment between primary and secondary sides. The work will be especially focused on a numerical technique for fast identification of inductances and coupling factors in different misalignment scenarios.
In a second step, once the wireless charging structure is chosen and its parameters identified, the equivalent circuit model will be developed. This model will be used to test control strategies for a given charging scenario and to evaluate the efficiency of the energy conversion.