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	
Family name	EL KHAMLICHI DRISSI
First name	Khalil
Email	lkhalil.drissi@uca.fr
Web reference	https://scholar.google.fr/citations?user=U74qBXMAAAAJ&hl=fr
Lab name	Institut Pascal
Lab web site	http://www.institutpascal.uca.fr/index.php/fr/
Polytech name	Polytech Clermont Ferrand
University name	Universite Clermont Auvergne
Country	France

PhD information	
Title	Efficient Power Drive of Hybrid and Electric Vehicles
Main topics regards to CSC list (3 topics at maximum)	New high performance energy saving technology (V-4)

Required skills in science and engineering	Power electronics, microcontroleur programming, Matlb/simulink

Subject description (two pages maximum)

Recently, due to global warming concerns, higher efficiency acquisitiveness, and soaring of the fuel price, electric/hybrid vehicles have attracted more attentions over Internal Combustion Engine (ICE). Due to modern hardware/controlling technology, these highly competitive vehicles are predicted to common transport, in the near future. Conventionally, in these vehicles in order to respect battery safety and efficiency concerns, low input DC voltage level has been preferably used. Hence, a DC/DC stage, followed by the Voltage Source Inverter (VSI) stage, is design to boost dc-link voltage level approximately by the factor of two (i.e., in Toyota Prius).

Therefore, the total efficiency is further deteriorated due to presence of massive passive components. Nowadays, Voltage Source Inverter (VSI) has been widely used; as a distributed generator in order to improve power system configurations or as motor drive. For medium or low voltage applications, high attention has been paid to two-level VSI according to its simple structure and controlling system in comparison with resent generations of Multi-Level Converters.

The proposed thesis is based on a new strategy of control called Near-State PWM (NSPWM) method. This strategy of control is adapted to be implemented in dual-VSI fed open-end motor structure. It is proposed with primary aiming to enhance efficiency and highly mitigate current THD (low-order triplen harmonics). The two possibilities to synthesis desire output voltage, while achieving the above mention aims, which are; fixing Phase Angle Displacement (PAD) between two Voltage Source Inverters (VSIs) to 120° while adjusting Modulation Index (MI), or fixing MI to the pre-determined value while adjusting PAD. Furthermore, the proposed approach enhances not only efficiency via limiting the number of commutations within switching interval but also presents the fundamental background to correctly determine THD value of the output current. The principles of the proposed method form current THD and switching loss point of view have been theoretically evaluated.

We already proposed an innovation with three main advantages:

- Efficiency is improved up to 5% due to less switching,
- Voltage and current common-mode are reduced by 66%, reducing electromagnetic interference and limiting the use of high frequency filter,
- Digital implementation of the control strategy preserves the power structure,

These major advantages introduced the proposed approach as highly competitive to be applied in dual-VSI without adding any extra hardware, expenses, or complex calculations.

Based on this innovative research developed by our group, we suggest to go further in term of efficiency and reliability of the power Drive during this thesis.

We suggest to improve the control strategy to increase the battery life and to reduce the input filter size. Also, according to last recent semi-conductors improvements, we plan to implement the mentioned strategy of control to a new setup with a full bridge of Silicon Carbide (SiC) switches.

A benchmark between two test benches (IGBT technology already available in the laboratory) and SiC technology (that have to be built) will be done.
Our group has 30 year experience on power electronics and is active on power Drive especially for Hybrid and Electric Vehicles (HEV), last achievements are based on three international patents and three international publications with high impact factor (more than 7).
The goal of this thesis is to increase the efficiency of the power converter and to increase the life duration of the main battery source.
A new patent covering a broader range of claims will be a necessary step to transfer this technology to international companies.

This thesis will be supervised mainly by two persons:
Pr Khalil EL KHAMLICHI DRISSI, email: khalil.drissi@uca.fr
Dr Christophe PASQUIER, email: Christophe.pasquier@uca.fr