Faculty of Engineering and Information Technology

Research of Inductive Power Transfer System for Electric Vehicle

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Research of Inductive Power Transfer System for Electric Vehicle

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Certificate of Original Authorship

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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Publications and Conference Contributions

The following publications are part of the thesis

Peer reviewed international scientific journal publications

1. S. Wang and D. G. Dorrell, "Loss analysis of circular wireless EV charging Coupler," in IEEE Trans. Magn., vol. 50, no. 11, pp. 1-4, Nov. 2014.
2. S. Wang and D. G. Dorrell, "Copper loss analysis of EV charging coupler," IEEE Trans.Magn., vol. 51, no. 11, pp. 1-4, Nov. 2015.
3. S. Wang, D. G. Dorrell, Y. Guo and M. F. Hsieh, "Inductive charging coupler with assistive coils," IEEE Trans. Magn., vol. 52, no. 7, pp. 1-4, July 2016.

Peer reviewed international scientific conference publications

1. S. Wang and D. G. Dorrell, "Review of wireless charging coupler for electric vehicles", Proc. IEEE 39th Annu. Conf. Ind. Electron. Soc. (IECON), pp. 7274-7279
2. S. Wang and D. Dorrell, "Simulation of electric vehicle inductive charging system," 2015 IEEE 11th International Conference on Power Electronics and Drive Systems, Sydney, NSW, 2015.

Abstract

Electric vehicles are a promising option for future transportation. The technology related to these have undergone rapid development over the last two decades and there are now many commercial electric vehicles available on the market. However, consumers still suffer from the "range anxiety" due to the limited driving range and long recharging time (refuelling time) compared to traditional internal combustion engine vehicles. Wireless charging is an alternative recharging option; currently the usual recharging method uses plug-in charging. With wireless charging, the connection between grid and vehicle can be established in less than a second without any manual operation. Therefore, recharging EVs can take place during a short stop or in motion. This means that there are more recharging windows available during vehicle use which would effectively extend the range of the vehicle and reduce consumers "range anxiety".

This work is divided into three parts. The first part addresses the background and reviews the literature on EV recharging technologies. This is formed from first two chapters: Chapter 1 provides the introduction and outline of this thesis; Chapter 2 puts forward a literature review of the state of the art of recharging technology. The design of the wireless charging coupler is reviewed in this chapter.

The second part is the study of the inductive charging system. Chapter 3 introduces the wireless charging pad analysis, which includes a circular pad and a rectangular pad analysis. The parameters of the pads are analysed. An analytical and numerical combined method for resistance analysis is introduced to wireless charging coupler resistance analysis which is

the first contribution of this research. And Chapter 4 proposes a pad geometry with assistive coils which is a new arrangement that improves the coil coupling which is the secondary contribution of this study. Chapter 5 analyses the inductive power transfer system at circuit level, and experiment validation is carried out.

Finally, conclusions and future work are given in Chapter 6.

Keywords: *EV, Wireless charging technology, Pad design, Pad analysis, Inductive charging system analysis*

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Nomenclature

Global abbreviations used in this thesis

AC	=	Alternating current
CO_2	=	Carbon dioxide
DC	=	Direct current
EMI	=	Electromagnetic interface
EV	=	Electric vehicle
FEA	=	Finite element analysis
FEM	=	Finite element method
HEV	=	Hybrid electric vehicle
HF	=	High frequency
MRCT	=	Magnetic resonance coupling transfer
PFC	=	Power factor correction
PMCT	=	Permanent magnet coupling transfer
SWC	=	Stationary wireless charging
WPT	=	Wireless power transfer