Scientific Project

Theme: Switched Flux Permanent Magnet Machines with Hybrid Magnets (NdFeB and Ferrite) for Electrical/Hybrid Electrical Vehicle Applications.

RESEARCH OBJECTIVES AND METHODOLOGY OF THIS PROJECT

The switched flux (or flux switching) permanent magnet (SFPM) machines are attracting increasing interest in both industry and academia mainly due to its high torque density and simple and robust rotor structure. As a result, it has gained foothold in a wide range of applications from domestic appliance, renewable energy and electrical or hybrid electrical vehicles (EV or HEV). This project however aims to design and test new types of SFPM machine for EV and HEV applications, in which both high torque density and wide constant power speed range are main requirements. In conventional SFPM machines, often only one type of magnets are used, i.e. NdFeB for high torque density while Ferrite for low cost and high constant power speed range. However, although NdFeB can provide attractive torque/power performance, its constant power speed range is restricted due to difficulty in flux weakening operation. On the contrary, the SFPM machine with Ferrite as magnets can often have better flux weakening capability and hence larger constant power speed range, but its torque density is poorer due to much lower magnet energy product. Therefore, the objective of this project is to develop SFPM machines with hybrid magnets (NdFeB and Ferrite) which possess the merits of both types of magnets, i.e. high torque density and wide constant power speed range, and hence suitable for EV and HEV applications.

The performance of the aforementioned SFPM machines with hybrid magnets will be comprehensively investigated. The comparison in terms of static torque, torque speed characteristics and cost, etc. against Ferrite (or NdFeB) quantity will be carried out so that an optimized topology which needs to be low cost but still have good electromagnetic performance can be achieved. Other topologies for conventional SFPM machines can also be employed, e.g. C-core, E-core and modular structures, etc., which can achieve performance such as fault tolerance and hence provides extra possibility for SFPM machines to be used in aerospace applications.

Providing the rich contents of this project, they cannot be all finalised within the required project duration (1 week). However, this project can lay a foundation for the follow-on project with SATIE laboratory or lead to a joint supervision of PhD or Master of Science (MSc) project or at least a joint IEEE journal paper.

PARTICIPANTS OF BOTH PARTIES:

- Laboratoire SATIE (Pôle CSEE[1], groupe SETE[2]) : Lionel VIDO
- Electrical Machines and Drives Group (EMD) at The Sheffield University: Guang-Jin LI

METHODS AND PLANNED ACTIONS:

- Software: MATLAB, ANSYS.
- Materials: Test bench including SFPM machines, PC, dSpace, torque sensor, position sessor, DC machines,….
- Joint supervision of PhD students, MSc students or final year engineering students.

[1] Composants et Systèmes pour l'Energie Electrique.
[2] Systèmes d'Energie pour le Transport et l'Environnement