

Guest Editorial:

Electrical Machines and Power Electronics

1 INTRODUCTION

Nowadays extensive consumption of fossil fuels lead to global warming and production of carbon dioxide. The attempt has been made to use wind generators, enhances the efficiency of the electric motors, and introduces electric machines with new configurations and progress in different applications. Efficiency improvement is very important factor for electrical generators and motors. In addition to efficiency, other major goals in electric machines development include low mass, high power density, reliability, wide speed range, and robustness and fault-tolerant design. Different supply voltage levels and specific operating cycles leads to entirely new electrical machines topologies,

Power electronics devices plays an important role in many electrical equipment and system in one or more ways. Many device supplied by electrical power is driven by power electronics which convert electrical energy of one type into another type, such as AC to DC. However, this is just the narrow technical description; the impact of power electronics in real-world is much wider. Nowadays we are seeing more and more examples of just how important power electronics and all those who work in the field are. Unfortunately, only one paper has been accepted in power electronics category.

2 CONTRIBUTED PAPERS IN THE SPECIAL ISSUE

15 contributions were received for this special issue and reviewed for possible publication. After this peer review at least by three reviewers, 10 papers were accepted for inclusion in this issue.

The accepted papers are grouped into four main categories: renewable energy, faults diagnosis, electrical machines design and power electronic devices.

Renewable Energy

The 1st paper deals with the dynamic output

feedback robust stabilization of the large wind turbine generator in the presence of time-varying delay and polytopic uncertainty. Two critical assumptions are uncertain, and the blade-pitch control input actuates by a time-varying unknown delay parameter. A novel algorithm has been proposed to design a proper controller for this system based on the Lyapunov Krasovskii functional approach. The obtained results reveal the superiority of the proposed controller compared to the existing controller.

In the 2nd paper, a permanent magnet flux switching generator has been properly and optimally designed to enhance the power, improve efficiency and reduce vibration and noise. This machine is employed as a small-scale efficient wind turbine generator. The spoke arrangement, a toothed rotor with a single-layer slot, and a PM inside the stator are considered to achieve a low cogging torque and high output power.

Fault Diagnosis

The 3rd paper considers wound rotor induction machine as a medium-power wind turbine and traction systems. Since the machine operates under harsh and difficult conditions, its fault diagnosis is crucial. Stator current signature has been used for rotor asymmetry fault diagnosis. The method is a high-resolution technique based on chirp-Z transform. To demodulate fault characteristic frequency as pre-processing stage, Teager-Kaiser energy operator technique has been employed. The proposed method has less complexity compared to traditional fast Fourier transform method.

The 4th paper deals with continuous condition monitoring of an induction-motor-driven centrifugal pumps. Electrical signals of the motor is used as a non-intrusive approach towards evaluating the efficiency employing the nameplate data. The pump characteristic curve, impeller speed and affinity laws are adopted to estimate the efficiency using a hybrid

method. A simple data acquisition system to acquire motor current and voltage signals, along with a microprocessor to implement the algorithms, has been integrated into a single affordable board for continuous efficiency monitoring purpose.

The 5th paper indicates that artificial intelligence is capable to diagnose and discriminate faults in electrical machines. Generally, sufficient data require for initial training, which is very difficult to collect it for operating electrical machines in the field. This paper introduces an effective approach to provide the required training data from simulation of a three-phase induction motor in the healthy as well as the stator inter-turn fault, broken rotor bar fault, and mixed eccentricity fault. Then, for each fault case, some fault indices extracted from the stator line current for training a suitable support vector machine (SVM) model to detect and discriminate the fault condition. The attained results confirm the trained SVM models are equally able to detect and discriminate the faults.

The 6th paper provides a review of deep learning-based methods for fault diagnosis of electrical motors. Traditional fault diagnosis techniques have limitations in accurately detecting and classifying motor faults. Deep learning has emerged as a promising approach for improving fault diagnosis accuracy. This review discusses various deep learning architectures, such as convolutional neural networks, recurrent neural networks and autoencoders, for motor fault diagnosis. Additionally, it examines different datasets and features used in these methods, highlighting their advantages and limitations. The challenges and future research directions in this field such as data augmentation, transfer learning, and interpretability of deep learning models have been proposed.

Electrical Machines Design

Paper 7th paper introduces a novel design optimization method for a multi-layer switched reluctance motor (SRM) aiming to reduce the torque ripple and enhance the mean torque. It is noted that the mean torque of the multi-layer SRM is higher than that of the conventional one-layer SRM. The design of experiments algorithm has been employed to determine the optimal ratio of stator/rotor poles arcs. Finite element analysis is used to predict instantaneous torque waveform of the motor.

The 8th paper investigates conical electrical machine which capable to develop higher torque and efficiency compared with conventional

electrical machines. Therefore, these machines could be appropriate choice in heavy machinery and industrial equipment. Besides, its compact structure let the user to integrate into manufacturing processes. Its magnetic gears (MGs) feature is other advantage of the machine. The introduced hybrid structure has both the advantages of radial flux and axial flux structures of MG. The permanent magnets have been shaped properly to enhance the output characteristics of the system. The genetic algorithm is used to maximize its torque density.

In 9th paper introduces a novel technique to design and optimize a 1.5 kW, 4-pole, 36-slot salient-pole permanent magnet synchronous machine (SPPMSM) based on a three-step skewed pole shoe method to reduce the output torque ripple and the cogging torque. In the first step, an initial model of the SPPMSM is designed, simulated, and verified through the Finite-Element method (FEM). The significant results obtained from the optimized model indicates that the output average torque and the air gap flux density are increased approximately by 12.7% and 3.3%, respectively compared to the initial design. The torque ripple has been decreased by about 16%. The cogging torque in the initial model machine was 0.036 Nm and with a 19.4% reduction, in the optimized model, it is 0.029 Nm.

Power Electronics

The 10th paper emphasizes that it is essential to improve the structure of voltage source inverters (VSIs) to increase renewable energy sources voltage gain. The split-source inverter (SSI) is a single-stage topology that uses the same number of power switches and switching states as VSI with boosting capability and the continuous input current. Three-phase switched-inductor SSI (SI-SSI) increases the voltage gain of conventional SSI. Besides, the modulation scheme impacts the inverters' performance. Space vector pulse width modulation (SVPWM) operates more efficiently than the third-harmonic injection pulse width modulation (THIPWM) and sinusoidal pulse width modulation (SPWM). However, varying the duty cycle of charging the inductors in each switching cycle increases the low-frequency ripples on the DC side of the inverter. To overcome this drawback in SVPWM, the modified SVPWM has been proposed in which the interval corresponding to zero states is redistributed to charge both inductors of SI-SSI with similar constant duty cycles. Thus, the low-frequency components on the inductors' current and

capacitor voltage are decreased without affecting the active states.

3 SUMMARY

The papers in this special issue indicates that more research in electrical machines is essential for further development of transportation electrification, efficient use of renewable energy, and new applications of electrical machine in future. This applies to the novel and most appropriate topologies, robust designs of different electrical machines, their control, parameters estimation, and fault diagnosis. Condition monitoring of electrical motors and generators are vital to use them efficiently over their life span. Power electronics devices are essential parts of any energy conversion system to enhance their performance.

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I would like to thank the authors for contributing novel ideas and research results to this special issue. Our gratitude goes to the reviewers, whose expertise was necessary for the professional and unbiased evaluation of the submitted manuscripts. We hope that the published papers in this issue stimulate the scientific and technical community to further contribution in the electrical machines and power electronics applications in renewable energy and electric vehicles. Finally, I appreciate to the editor-in-chief of the journal and the editorial office staffs for their support in preparing this special issue.

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