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Guest Editorial:
Electrical Machines and Power Electronics

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1- Introduction

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

Power electronic devices play an important role in many electrical equipment and systems 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 a narrow technical description; the impact of power electronics in the 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 the 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 machine 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 is actuated 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 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 machines as 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 the chirp-Z transform. To demodulate fault characteristic frequency as a pre-processing stage, the Teager-Kaiser energy operator technique has been employed. The proposed method has less complexity compared to the 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 are used as a non-intrusive approach to evaluating the efficiency of 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 purposes.

The 5th paper indicates that artificial intelligence is capable to diagnose and discriminate faults in electrical machines. Generally, sufficient data is required for initial training, which is very difficult to collect for operating electrical machines in the field. This paper introduces an effective approach to provide the required training data from the 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 are 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 the experiments algorithm has been employed to determine the optimal ratio of stator/rotor pole arcs. Finite element analysis is used to predict the instantaneous torque waveform of the motor.

The 8th paper investigates conical electrical machines which capable of developing higher torque and efficiency compared with conventional electrical machines. Therefore, these machines could be the appropriate choice for heavy machinery and industrial equipment. Besides, its compact structure lets the user integrate into manufacturing processes. Its magnetic gears (MGs) feature is another 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 indicate 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 o 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 source's 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 indicate that more research in electrical machines is essential for further development of transportation electrification, efficient use of renewable energy, and new applications of electrical machines in the future. This applies to the novel and most appropriate topologies, robust designs of different electrical machines, their control, parameter estimation, and fault diagnosis. Condition monitoring of electrical motors and generators is 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

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EDITOR BIOGRAPHY

Professor Jawad Faiz received his B.Sc., M. Sc., from the University of Tabriz and Ph.D. degrees from the University Newcastle upon Tyne, UK, in 1976 and 1988, respectively, all in Electrical Engineering. Since 1976, he has been with the University of Tabriz, Iran and since 1999 he has been a full Professor of Electrical Engineering at the University of Tehran, Iran. He is a Fellow of the Iran Academy of Science, a Member of the Euro-Med Academy of Arts and Sciences, a Distinguished Professor of the University of Tehran, and a Senior Member of IEEE. His research interests include design, modeling, analysis, optimization, operation and control, and fault diagnosis of electrical machines drives, and transformers. He has been a project team leader of many national industry-funded projects. He published over 300 papers in International scientific journals and presented over 310 papers in International scientific conferences. He is the Editor of IEEE Transactions on Energy Conversion. Dr. Faiz also is the author of three books published by Springer, IET, and IEEE-Wiley. He is the Editor of IEEE Transactions on Energy Conversion. He has received many international and national awards for his research activities.

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