Introduction to the Special Section on Advances in Diagnosis for Electrical Machines, Power Electronics, and Drives—Part I

WITH THE large increase in the electric machines population in recent years, the topics of condition monitoring and fault diagnosis are becoming attractive and critical. These techniques play an important role in modern industrial processes. By now, all conferences dealing with electrical machines and drives include, in a systematic way, sessions fully dedicated to condition monitoring and diagnosis. Therefore, interesting scientific contributions on the subject are rapidly growing. This is the reason why it is already the fourth time that a Special Section on diagnostics techniques in power electrical engineering has been published in the IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS after the issues of December 2008 [1], November 2009 [2], and May 2011 [3]. As in the last case, most of the papers published in this "Special Section on Advances in Diagnosis for Electrical Machines, Power Electronics, and Drives—Part I" are coming from the 2011 Symposium on Diagnostics for Electrical Machines, Power Electronics and Drives (SDEMPED 2011) organized in Bologna, Italy, in September 2011.

Even if modern diagnostic techniques in power electrical engineering are considered as mature, there are still innovations to be published. Therefore, among the 188 papers submitted to this Special Section, 28 have been selected to be published in two parts. This Introduction is related to the first 14 selected papers, which have been divided into three topics dealing with:

- electrical machines failures detection with bearings (four papers), backlash phenomena (one paper), shaft trajectories (one paper), and winding short circuits (one paper);
- adjustable-speed drives with permanent-magnet synchronous machines (PMSMs) winding short circuits (one paper), drive sensors (one paper), prognosis (one paper), inverter open-circuit detection (one paper), and multiphase induction motors (one paper);
- power systems (one paper) and transformers (one paper) particular fault detection.

Nowadays, fault detection in electrical machines is not only related to electromagnetic matters such as windings and air gap, and consequently, much interests have been directed toward both thermal and mechanical phenomena. The first group of seven papers on electrical machines is a clear proof of these new interests. The paper from Delgado *et al.* is related to bearings early fault detection by using a specific neural network. The second paper from Immovilli *et al.* is dedicated to bearings fault detection in induction machines with interests to the external induced vibration. The third paper from Gong and Qiao deals with bearings fault detection in direct-drive wind turbine generators. The fourth paper from He *et al.* is related to the investigation of plastic bearings faults by using a data mining approach. The fifth paper from Bogiatzidis *et al.* develops the detection of backlash phenomena in large power machines drives. The sixth paper from Urresty *et al.* is dedicated to the observation of shaft trajectories in PMSMs submitted to the demagnetization. Finally, the paper from Cheng and Habetler develops an automotive application on a low-cost windings short-circuit fault detection in alternators by the measurement of the dc output current. These papers have clearly shown the importance of using the electrical machines as a primary sensor, whatever the nature of the fault detection is. It has been clearly shown that many bearings faults can be detected from the electrical part of the machine itself.

The second group of five papers deals with adjustable-speed drives in all their diversity of both design and applications. Electrical drives are moving toward more "intelligence" inside. Therefore, modern electrical drives integrate fault-tolerant control techniques even if not really connected to fault diagnosis. In order to achieve these performances, nonstandard drives have been designed the last ten years. The first paper from Sarikhani and Mohammed is related to windings interturn short-circuit detection for PMSM by using the estimation of the internal back electromotive force. The second paper from Zhang *et al.* deals with speed, current, and voltage sensors fault detection in PMSM drives with an extended Kalman filter. The third paper from Estima and Marques Cardoso develops a new open-circuit fault detection scheme in inverter-based drives by using a current sensor signature analysis. The fourth paper from Zarri *et al.* is dedicated to asymmetry detection in a multiphase induction machine from its drive point of view. It is certainly an interesting alternative to increase the number of phases of ac machines above three in order to develop more fault-tolerant electrical drives. The last paper of this group from Strangas *et al.* is dedicated to failure prognosis in PMSM drives based on a statistical approach. Even if more complex, electrical drives can benefit from fault detection capabilities as well. On the contrary, for grid-connected electrical machines, the number of sensors is larger, and the fault detection can be achieved by using drives sensors and appropriate signal analysis.

The third group of papers is related to power systems and transformers, which represent a field in which diagnostics techniques will be more and more used in the future with the integration of more generators in the electrical grid and with the birth of the smart grids technology, for which reliability and fault detection are fundamental. The first paper from Hu *et al.* is related to the hierarchical approach of fault diagnosis in power systems by using a disturbance-based method. The second paper from Buticchi and Lorenzani treats the problem of dc bias in distribution power transformers. It is more than

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certain that condition monitoring of power systems is a very important topic for increasing reliability and availability of power on the grid.

Conclusion

The first part of this Special Section on Advances in Diagnosis for Electrical Machines, Power Electronics, and Drives is mainly related to apparatus, without too much focus on specific techniques, which will be reported in the second part. It can be observed that electrical machines are still in the majority to develop specific diagnostic techniques even for mechanical or thermal parts. Electrical drives are also under focus since they are key parts for the modern usage of electrical machines. The special fault-tolerant techniques from both power parts and control systems are also in emergence even if not yet a stable technology. Last but not least, power systems and transformers have been presented with a special focus on modern fault detection techniques.

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