Guest Editorial Special Section on Motor Fault Detection and Diagnosis

MOTORS are the workhorses of our industry. Safety, reliability, efficiency, and performance are some of the major concerns and needs for motor systems applications. With issues such as aging systems, high reliability demands, and cost competitiveness (e.g., motor operation efficiency and online service availability), the issues of preventive and condition-based maintenance, online monitoring, system fault detection, diagnosis, and prognosis are of increasing importance. The key issues for a successful motor operation are a quality motor, understanding of the application, choice of the proper type of motor for the application, and proper maintenance of the motor. However, the use of motors in today's industry is extensive and the motors can be exposed to different hostile environments, misoperations, manufacturing defects, etc. Different internal motor faults (e.g., short circuit of motor leads, inter-turn short circuits, ground faults, worn-out/broken bearings, broken rotor bars) along with external motor faults (e.g., phase failure, asymmetry of mains supply, mechanical overload, blocked rotor, underload) are expected to happen sooner or later. Furthermore, the wide variety of environments and conditions that the motors are exposed to can age the motor and make it subject to incipient faults. These types of faults usually refer to the gradual deterioration of the motor that can lead to motor failure if left undetected. Motor problems can cause crises that are expensive and quite annoying, in particular, if the problem could have been prevented.

Early fault detection, diagnosis, and prognosis allow preventative and condition-based maintenance to be arranged for the motor system during scheduled downtimes and prevent an extended period of downtime caused by extensive system failures, which improves the overall availability and performance, while reducing maintenance costs. For the fault detection problem, we would like to know if a fault exists in the system via online measurements. For the fault diagnosis problem, we do not only want to detect if the system has a fault, but we also want to isolate the fault and to find its causes. For the fault prognosis problem, in addition to diagnosing the fault, we would also like to estimate the remaining life of the equipment.

This "Special Section on Motor Fault Detection and Diagnosis" of the IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS focuses on the techniques for motor fault detection and diagnosis. Different researchers from different countries around the world have been devoting a significant amount of time and energy to achieve better motor fault detection and diagnosis schemes. This Special Section includes 14 papers from experts in the area of motor fault detection and diagnosis. The papers in this Special Section are grouped into five main categories.

- *Survey Papers:*
  1) "A Review of Induction Motors Signature Analysis as a Medium for Faults Detection," by M. El Hachemi Benbouzid in France.
  2) "Recent Developments of Induction Motor Drives Fault Diagnosis Using AI Techniques," by F. Filippetti, G. Franceschini, and C. Tassoni in Italy and P. Vas in the U.K.
- *Model-Based Approaches:*
  1) "Fault Detection and Diagnosis of Rotating Machinery," by K. A. Loparo, M. L. Adams, and W. Lin in the U.S., M. Abdel-Magied in Egypt, and N. Afshari in the U.S.
  2) "Application of Model-Based Fault Detection to a Brushless DC Motor," by O. Moseler and R. Isermann in Germany.
  3) "Fault Detection and Diagnosis of Permanent-Magnet DC Motor Based on Parameter Estimation and Neural Network," by X.-Q. Liu, H.-Y. Zhang, J. Liu, and J. Yang in China.
- *Signal Processing Approaches:*
  1) "Induction Machine Condition Monitoring with Higher Order Spectra," by N. Arthur and J. Penman in the U.K.
  2) "Sequences of Field-Oriented Control for the Detection of Faulty Rotor Bars in Induction Machines—The Vienna Monitoring Method," by C. Kral in Austria, R. S. Wieser in Switzerland, and F. Pirker and M. Schagginger in Austria.
  3) "HOS-Based Nonparametric and Parametric Methodologies for Machine Fault Detection," by T. W. S. Chow in Hong Kong and H.-Z. Tan in Canada.
- *Emerging Technology Approaches:*
  1) "Neural-Network-Based Motor Rolling Bearing Fault Diagnosis," by B. Li, M.-Y. Chow, Y. Tipsuwan, and J. C. Hung in the U.S.
  2) "Hierarchical Motor Diagnosis Utilizing Structural Knowledge and a Self-Learning Neuro-Fuzzy Scheme," by D. Fuessel and R. Isermann in Germany.

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- *Experimentation:*
    1) "The Detection of Inter-Turn Short Circuits in the Stator Windings of Operating Motors," by G. Joksimović in Yugoslavia and J. Penman in the U.K.
    2) "Bearing Damage Analysis in a Large Oil-Ring-Lubricated Induction Machine," by R. Ong, J. H. Dymond, and R. D. Findlay in Canada.
    3) "Comparative Investigation of Diagnostic Media for Induction Motors: A Case of Rotor Cage Faults," by A. M. Trzynadlowski in the U.S. and E. Ritchie in Denmark.
- We also include the following paper:
    1) "Oil Well Diagnosis by Sensing Terminal Characteristics of the Induction Motor," by B. M. Wilamowski in the U.S. and O. Kaynak in Turkey,
    to provide readers another viewpoint of using motors in system fault detection application.

I hope that this Special Section will stimulate some of our readers' interest in the increasingly important and rewarding area of motor fault detection and diagnosis, as well as provide a reference for readers who are involved in this field. Certainly, there are many other experts in the area of motor fault detection and diagnosis, but their papers cannot be included in this Special Section due to page limitations. Interested readers can start with this issue to find out about related literature by following the references cited in each paper. I would like to thank all the authors in this Special Section for their hard work in preparing their manuscripts and for the help and patience of the Editor-in-Chief of the IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, Prof. J. Holtz, in making this important Special Section a success.

MO-YUEN CHOW, , *Guest Editor*
North Carolina State University
Department of Electrical and Computer Engineering
Raleigh, NC 27695 USA

Mo-Yuen Chow (S'81–M'–82–SM'93) received the B.S. degree from the University of Wisconsin, Madison, and the M.Eng. and Ph.D. degrees from Cornell University, Ithaca, NY, in 1982, 1983, and 1987, respectively, all in electrical engineering.

Upon completion of the Ph.D. degree, he joined the faculty of North Carolina State University, Raleigh, where he is currently a Professor in the Department of Electrical and Computer Engineering. He has also been a Consultant to Duke Power Company, Otis Elevator Company, Taiwan Power Company, J. W. Harley Company, and was a Faculty Intern at Duke Power Company. He is working in the areas of control and networking. His core technologies are diagnosis and control, artificial neural networks, and fuzzy logic. Since 1987, he has been involved in the areas of motors, process control, power systems, and communication systems. He has served as a Principal Investigator in several projects supported by the National Science Foundation, Center for Advanced Computing and Communication, Nortel Company, Electric Power Research Institute, Duke Power Company, ABB Company, Electric Power Research Center, and Army Construction Engineering Research Laboratory. He established the Advanced Diagnosis and Control Laboratory at North Carolina State University. He has authored one book, several book chapters, and more than 80 journal and conference articles related to his research work. He is the past President of the Triangle Area Neural Network Society.

Dr. Chow served as a Guest Editor for the IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS Special Issue on Application of Intelligent Systems to Industrial Electronics. He is currently the IEEE Industrial Electronics Society Vice President for Member Activities, an Associate Editor of the IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, an AdCom Member of the IEEE Industrial Electronics Society, an AdCom Member of the IEEE Neural Networks Council, Chairman of the IEEE Neural Networks Council Regional Interest Group Committee, and past Editor-in-Chief of the *IEEE Industrial Electronics Society Newsletter*. In addition, he is listed in *Who's Who Among Asian Americans*.