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Tutorial – I

Artificial Intelligence-assisted Condition Monitoring in Power Electronics

Abstract:

Artificial intelligence (AI) has been applied to condition monitoring of power electronic systems (PES) since the 1990s in the literature, including signal acquisition, detection, diagnostics, prognostics, etc. Due to the limitations on computation unit, data availability, and AI tools capability, the AI-based condition monitoring solutions are not quite competitive as expected and their implementations in the industry field are rare. Currently, these facts have drastically changed, considering that state-of-the-art AI tools like deep learning have been revolutionizing industrial areas such as computer vision and natural language processing. It is believed that these AI tools will deliver the overarching merits to power electronics as well since the PES are developing toward data-rich systems with the increasing awareness of data collection. Combining with the rapid development of computational platforms, they are forming solid foundations to tackle existing challenges in the field operation and accelerate industrial deployments. As a result, it is time to prepare for the paradigm shift to AI-assisted solutions, which will unleash the potentials of cutting-edge AI tools for condition monitoring in power electronics on various implementation levels including components (capacitors, semiconductor devices, etc.), power modules, and full-scale system.

The objective of this tutorial is to provide an overview of the latest development of AI-assisted condition monitoring on PES. As a synergy research field integrating data science and power electronics, this tutorial will discuss three relevant aspects including the concepts, case studies, and outlooks. The potential attendees are ranging from researchers who expect to get clicked to start this interdisciplinary research, to advanced ones who expect to be informed with the cutting-edge knowledge and frontiers in this field. The tutorial starts with a systematic flowchart of data-driven condition monitoring for PES. Compared to other data-driven fields, the observations from these case studies and other latest research will be discussed. The specific features and requirements of PES when applying AI tools will be summarized. Finally, it will present the outlooks on the tailored AI techniques for condition monitoring of PES, e.g., data-light AI, computation-light AI, explainable AI, physics-informed AI. The open-access resources, identified challenges, and emerging opportunities in this field will be provided as well.

Presenters:

Dr Huai Wang – Professor at Aalborg University, Denmark
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Dr Huai Wang received BE degree in electrical engineering from Huazhong University of Science and Technology, Wuhan, China, in 2007 and Ph.D. degree in power electronics, from the City University of Hong Kong, Hong Kong, in 2012. He is currently Professor with the Center of Reliable Power Electronics (CORPE), Department of Energy Technology at Aalborg University, Denmark. He was a Visiting Scientist with the ETH Zurich, Switzerland, from Aug. to Sep. 2014, and with the Massachusetts Institute of Technology (MIT), USA, from Sep. to Nov. 2013. He was with the ABB Corporate Research Center, Switzerland, in 2009. His research addresses the fundamental challenges in modeling and validating power electronic component failure mechanisms and application issues in system-level predictability, condition monitoring, circuit architecture, and robustness design. He leads a project on Light-AI for Cognitive Power Electronics. Dr. Wang received the Richard M. Bass Outstanding Young Power Electronics Engineer Award from the IEEE Power Electronics Society in 2016, and the Green Talents Award from the German Federal Ministry of Education and Research in 2014. He is currently the Chair of the IEEE PELS/IAS/IES Chapter in Denmark. He serves as an Associate Editor of IEEE Journal of Emerging And Selected Topics in Power Electronics and IEEE Transactions on Power Electronics.

Dr Shuai Zhao received the BE (Hons), ME, and Ph.D. degrees in information and communication engineering from Northwestern Polytechnical University, Xi'an, China, in 2011, 2014, and 2018, respectively. He is currently a postdoctoral researcher with the Center of Reliable Power Electronics (CORPE), Department of Energy Technology, Aalborg University, Denmark. From Sep. 2014 to Sep. 2016, he was a visiting Ph.D. student with the Department of Mechanical and Industrial Engineering at the University of Toronto, Toronto, ON, Canada, with a scholarship from China Scholarship Council (CSC). In Aug. 2018, he was a visiting scholar with the Power Electronics and Drives Laboratory, Department of Electrical and Computer Science at the University of Texas at Dallas, Richardson, TX, USA. His research interests include system informatics, intelligent condition monitoring, diagnostics & prognostics, and tailored AI tools for power electronic systems.