Journal of Dynamics, Monitoring and Diagnostics, 2022, 1, 125-126
https://doi.org/10.37965/jdmd.2022.132

EDITORIAL

Special Issue on the Application of Machine Learning and Artificial Intelligence in Fault Diagnostics

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(Received 07 September 2022; Revised 09 September 2022; Accepted 09 September 2022; Published online 09 September 2022)

I. INTRODUCTION AND SCOPE

The rapid development of data science and associated artificial intelligence (AI) methods has seen a substantial increase in interest in their application to anomaly detection, fault diagnostic, and prognostic challenges across a wide range of industrial and civil applications. Such approaches may well be the complement that is sought for conventional physical model-based and statistical approaches which often struggle to achieve the desired performance when dealing with complex engineering systems. Researchers have started to apply a range of machine learning and AI-based methods to the large-scale, multidimensional data that is often associated with large-scale sensor systems, particularly those which involve internet of things (IoT) devices. There is clear scope for the further development of such approaches, such as deep learning, transfer learning methods, and AI models, to enhance the performance of condition monitoring and associated technologies, and this is the key motivation for this Special Issue. This Special Issue on the Application of Machine Learning and Artificial Intelligence in Fault Diagnostics contains six papers.

II. THE MAIN INTRODUCTION OF THE PAPER IN THE SPECIAL ISSUE

The paper by Shengkai Wang and Jie Zhang is aimed at extracting features from the online process measurements using the Andrews function. A convolutional neural network is used to further extract diagnostic information from the Andrews function outputs. And, the outputs of the convolutional neural network are then fed to a single hidden layer neural network to obtain the final fault diagnosis result. Applications to a simulated continuous flow stirred-tank reactor (CSTR) process show that the proposed fault diagnosis system gives much better performance than the conventional neural network-based fault diagnosis system and manual selection of features in Andrews' function outputs.

The paper by Jian Tang et al. is aimed at developing a 1D adder neural network with a wide first-layer kernel (WAddNN) for bearing fault diagnostics with low computation costs. The l1-norm distance between filters and input features is used as the output response, which makes the whole network almost free of multiplicative operations. One of the main contributions is that the adder layer can replace the convolutional layer in bearing faults and be seen as a basic building block for edge-end diagnostic models with limited computational resources.

The paper by Hongkun Li et al. is aimed at solving the problem of rotating stalls for centrifugal compressors from real engineering by proposing a new intelligent method of the SDKAE Network based on pressure pulsation signals. From the experimental results, it can be seen that the flow state of the centrifugal compressor is accurately judged, and the rotation stall early warning of the centrifugal compressor at different speeds is realized. The authors believed that their work had laid a good foundation for using intelligent methods for the maintenance of the centrifugal compressor.

The paper by Oscar García Peyrano et al. is aimed at solving an attractive topic of unbalance detection in the area of using intelligent methods in machinery fault detection, which is realizing online unbalance diagnosis of a large multistage steam turbine generator that has a multibody model of a 640-MW steam turbine flexible rotor to simulate mechanical unbalance in several positions along the shaft, which can solve the mechanical unbalance diagnosis problem by generating vibration data from a series of representative unbalance conditions.

The paper by Huan Wang et al. is aimed at building an efficient learning method for long-range dependencies. This paper introduced the idea of a nonlocal mean (NLM) algorithm in the field of time series signal de-noising into the 1D convolutional neural networks (CNN) and constructed a 1D nonlocal block (1D-NLB), which computes the response at a position as a weighted average of the features at all positions. It could build connections between one position and any other position so that it could capture their dependencies. This paper validates the effectiveness of the proposed method on two bearing datasets including the wheelset bearing dataset of high-speed trains and the Case Western Reserve University bearing dataset under multiple noise conditions.

The paper by Debasish Mishra is aimed at providing a detailed description of how Industry 4.0 technologies can be used to implement a welding process. An Industry 4.0 framework for continuous monitoring and defect control based on real-time feedback is presented in this article for friction stir welding to improve the efficiency of manufacturing systems. The sensors, the edge hardware, the cloud-based systems, and the deep neural networks in this framework are integrated in real time to work together seamlessly. Real-time monitoring and multi-sensor collaboration are the focus of this work.

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Acknowledgments

We would like to thank all of the authors who provided valuable contributions to this special issue. We are also grateful to the Review Committee for the feedback provided to the authors. Finally, we would like to express our sincere gratitude to Professor Fulei Chu, Editor-in-chief, for providing us with this unique opportunity to present our works in the international journal the Journal of Dynamics, Monitoring and Diagnostics.