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EDITORIAL

IEEE ACCESS SPECIAL SECTION EDITORIAL: COMPLEX SYSTEM HEALTH MANAGEMENT BASED ON CONDITION MONITORING AND TEST DATA

The global manufacturing industry is facing a crucial transformation with the rapid developments of German Industries 4.0, Industrial Internet of the U.S., and China Manufacturing 2025. This transformation requires higher reliability and safety of complex systems. Therefore, intelligent diagnostic and predictive technologies are attracting more research interests as efficient solutions to improve the system reliability. The realization of system health management based on condition monitoring and testing information is of great value and significance to improve the reliability and safety of those complex systems in aeronautics, astronautics, oceanography, industrial manufacturing, new energy resources, and other fields.

This Special Section in IEEE ACCESS focuses on the aeronautics, astronautics, and industrial manufacturing fields to showcase the progress, algorithms, and applications of analyzing and extracting system health indices from condition monitoring and testing information. Fifty articles were submitted and twenty of them were accepted. These articles cover several topics of complex system health management including fault diagnosis methods, remaining useful life prediction approaches, etc. Each article was blindly reviewed by three reviewers, including guest editors and external reviewers.

The first article in this Special Section is ''Incipient fault diagnosis of roller bearing using optimized wavelet transform based multi-speed vibration signatures'', by Z. Huo, *et al.* This work presents a new multi-speed fault diagnostic approach based on the self-adaptive wavelet transform components generated from bearing vibration signals. The parameters in the applied Impulse Modeling-based continuous wavelet transform model are optimized by particle swarm optimization and Broyden-Fletche-Goldfarb-Shanno-based quasi-Newton minimization algorithms. The fault signature extraction and fault classification are implemented based on a 3-D feature space of the statistical parameters and a nearest neighbor classifier, respectively. The experimental results have achieved an overall accuracy of 100%. Moreover, the generated discriminatory fault signatures are suitable for multi-speed fault data sets.

The second article in this Special Section is ''A fault diagnosis approach for rolling element bearings based on RSGWPT-LCD bilayer feature screening and extreme learning machine'', by Q. Tong, *et al.* This work proposes a novel hybrid approach detecting bearing faults and monitoring the operating status of rolling element bearings in modern rotating machineries. The fault features are extracted based on the redundant second-generation wavelet packet transform and local characteristic-scale decomposition. The fault features are then used for faults classification based on singular value decomposition and extreme learning machine. The simulation and practical bearing vibration signals under different conditions are used for evaluation. The results indicate that the method is feasible and effective for the rolling element bearing fault diagnosis.

The third article in this Special Section is ''Impact of electrical contact resistance on the high-speed transmission and on-line diagnosis of electrical connector intermittent faults'', by Q. Shen, *et al.* This work proposes an on-line diagnosis method in condition of the single-end test for the electrical connector intermittent faults (IFs). The impact of the electrical contact resistance (ECR) on high-speed transmission is studied and the connector fault feature in condition of the single-end test is extracted, which is called insertion loss increment (ILI). The verification results show that ILI can truly exhibit the variation of ECR. The error of ILI-based diagnosis method is only about 1%.

The fourth article in this Special Section is ''Statistical analysis of time-varying characteristics of testability index based on NHPP'', by Z. Zhao, *et al.* This work presents a failure occurrence model based on the non-homogeneous Poisson process (NHPP) to depict failure occurrence samples under the assumption of minimal maintenance policy. Each failure detection action is depicted based on binominal cumulative probability function (CDF). Under the assumptions made in this article, the constant failure detection rate is not suitable in all stages of the failure occurrence process.

The fifth article in this Special Section is ''TagCare: using RFIDs to monitor the status of the elderly living alone'', by L. Zhu, *et al.* This work designs and implements a motion detection system based on passive radio frequency identification tags. The key finding is that static, regular action, and sudden falls make an impact on the RSS and Doppler frequency values differently. These kinds of features are helpful for elderly status detection. The signal data are pre-processed based on the wavelet transform and the fall detection accuracy is improved based on the support vector machine algorithm. The overall system is implemented and called TagCare. The

extensive experiments are conducted to demonstrate the accuracy and efficiency of TagCare in elderly movement detection and fall behavior identification.

The sixth article in this Special Section is ''Bearing fault diagnosis using fully-connected winner-take-all autoencoder'', by C. Li, *et al.* This work uses the fully-connected winner-take-all autoencoder in bearing fault diagnosis. A soft voting method is implemented to aggregate prediction results of signal segments sliced by a sliding window to increase accuracy and stability. The overall work is evaluated based on the simulated data set and compared with some state-of-art fault diagnosis methods. The results indicate that the proposed method is with high precision and robustness based on a simple two-layer network.

The seventh article in this Special Section is ''Stacked sparse autoencoder-based deep network for fault diagnosis of rotating machinery'', by C. Shen, *et al.* This work proposes a stacked sparse autoencoder (SAE)-based machine fault diagnosis method. The collected non-stationary and transient signals are preprocessed with ensemble empirical mode decomposition and autoregressive (AR) models to obtain AR parameters, which are extracted based on the intrinsic mode functions (IMFs) and regarded as the low-level features for the inputs of the proposed diagnosis network. The results of experiments and comparisons indicate that the proposed method can extract more discriminative high-level features and better performance in rotating machinery fault diagnosis.

The eighth article in this Special Section is ''Research on distribution network fault recognition method based on time-frequency characteristics of fault waveforms'', by X. Qin, *et al.* This work presents a recognition method of distribution line fault type based on the analysis of time-frequency features of fault waveform. The characteristic parameters extraction formula is presented according to fault waveform data. Based on the multi-parameters fusion, the recognition logic is established. The experiment is conducted based on 136 groups of field fault waveform data. The results indicate that recognition success rate reaches 90%, which verifies the feasibility of using time-frequency characteristics of fault waveform to realize recognition of distribution line fault types.

The ninth article in this Special Section is ''A stochastic computational approach for the analysis of fuzzy systems'', by X. Song, *et al.* This work presents a stochastic computational model for fuzzy system reliability analysis. This research focuses on the efficiency improvement. The basic event failure possibility given by a fuzzy number is transformed into an expected value. The spread of the fuzzy number is given by the standard deviation of stochastic computational results. An illustrating example is applied for evaluation and the results indicate that this stochastic approach can efficiently evaluate the failure probability of a system.

The tenth article in this Special Section is ''Remaining useful life prediction for a machine with multiple dependent features based on Bayesian dynamic linear model and copulas'', by F. Sun, *et al.* This work proposes a multivariate degradation modeling approach based on the Bayesian dynamic linear model (BDLM) for remaining useful life calculation. The copula function is applied to capture the dependence among remaining useful life distributions. Two BDLM models are combined to establish the multivariate degradation model. The feature degradation can be predicted when the parameters are identified.

The eleventh article in this Special Section is ''VTB-RTRRP: variable threshold based response time reliability real-time prediction'', by C. Jin, *et al.* This work proposes a variable threshold-based response time reliability (RTR) real-time prediction framework based on the data-driven approaches. The response time threshold varies with the workload. Moreover, a real-time updating model between workload and RTR is built for RTR prediction based on the latest monitored data. A communication network is taken as an example for the validation and evaluation of the proposed method. The experimental results indicate that this continually updating model can obtain more accurate RTR prediction results.

The twelfth article in this Special Section is ''Theoretical and experimental studies of localization methodology for AE and microseismic sources without pre-measured wave velocity in mines'', by L. Dong, *et al.* This work focuses on acoustic emission (AE) and microseismic (MS) monitoring approach. An MS or AE source location method without the need for a pre-measured wave velocity is researched. The tests are conducted based on the pencil lead break and the thermal fracture in granite. The results show that the location accuracy of the proposed method is significantly improved. Then, the experiments are carried out in the Dongguashan copper mine in China. The results show that the calculated locations by the proposed method are in better agreement with the real blast coordinates. Another experiment is conducted based on the previously published data and compared with existing methods. All the experimental results indicate that the proposed method can not only decrease the location errors but also locate the MS/AE source in real time.

The thirteenth article in this Special Section is ''Effects of Anisotropy for P-wave Velocity on Locating Accuracy of Acoustic Emission Sources in Sandstone'', by J. Zhang. This work discusses the locating error caused by the anisotropy for P-wave velocity quantitatively. The locating experiments are carried out on the sandstone sample. Results show that the difference of wave velocity is large in different directions. The locating accuracy is strongly affected by the errors of wave velocity, which is up to 20.5%. The tests illustrate that the wave velocity should be measured in multiple directions for several times for acoustic emission (AE) sources locating.

The fourteenth article in this Special Section is ''Fragment anomaly detection with prediction and statistical analysis for satellite telemetry'', by D. Liu *et al.* This work proposes a fragment anomaly detection strategy based on the uncertainty estimation of least square support vector machine and statistical analysis. Some estimation indicators are also presented for the evaluation of the detection method. The experi-

ments are carried out based on both simulation data sets, open source data sets, as well as the real satellite telemetry data. The applicability of the proposed framework is tested based on different anomaly modes.

The fifteenth article in this Special Section is ''Impact of passivation layers on irradiation response of PNP transistors under different dose rates'', by X. Li, *et al.* This work investigates the effect of nitride passivation layer on the irradiation response of PNP bipolar junction transistors (BJTs) by Co-60 gamma ray under high and low dose rates. The excess base current and deep level transient spectroscopy are measured to analyze the damage mechanisms on BJTs with or without nitride passivation layer. Experimental results show that the low dose rate sensitivity for PNP transistors is enhanced both with and without nitride passivation layers. Moreover, the PNP BJTs with nitride layer is more serious than those without nitride layer. The PNP BJT with nitride passivation layers can generate greater density of interface traps with deeper energy level at a given dose rate. At the same time, hydrogen is an important factor influencing the dose rate sensitivity as well as the degradation of the BJT with nitride passivation layers.

The sixteenth article in this Special Section is ''Sparse reconstruction based on the ADMM and LASSO-LSQR for bearings vibration signals'', by W. Song, *et al.* This work introduces a novel method for reconstructing roller bearings vibration signals. The approach consists of Lasso via the alternate direction multiplier method (ADMM) and the optimization based on least square QR-fractorization (LSQR). The discrete cosine transformation is applied to achieve sparse signals. The signals are compressed based on the Gaussian random matrix. The signals are reconstructed based on the Lasso-LSQR by using ADMM. The experimental results indicate that the proposed method can keep sufficient reconstruction accuracy with high compressive ratio.

The seventeenth article in this Special Section is ''Industrial big data in an industry 4.0 environment: challenges, schemes and applications for predictive maintenance'', by J. Yan, *et al.* This work puts forth attributes of industrial big data processing and actively explores industrial big data processing-based predictive maintenance. Moreover, a novel framework is proposed for structuring multisource heterogeneous information, characterizing structured data with consideration of the spatiotemporal property, and modeling invisible factors. The proposed scheme is verified based on the analysis of multisource heterogeneous industrial data in remaining useful life prediction of key components of machining equipment.

The eighteenth article in this Special Section is ''Adaptive mode decomposition methods and their applications in signal analysis for machinery fault diagnosis: a review with examples'', by Z. Feng, *et al.* This work presents a systematic and up-to-date review on adaptive model decomposition in two major topics including mono-component decomposition algorithms and instantaneous frequency estimation approaches. There have been more than 80 representative articles published since 1998. Some examples are provided to illustrate performance of these papers.

The nineteenth article in this Special Section is ''Prognostics and health management: a review of vibration based bearing and gear health indicators'', by D. Wang, *et al.* This work reviews the vibration based bearing and gear health indicators in prognostics and health management. Health indicators construction is the key to predicting the remaining useful life. This review article is helpful for designing further advanced bearing and gear health indicators and provides a basis for predicting the remaining useful life of bearings and gears.

The twentieth and final article in this Special Section is ''A PSO optimization scale-transformation stochastic-resonance algorithm with stability mutation operator'', by L. Tong, *et al.* This work analyzes the parameters that influence system stability based on the scale-transformation stochastic-resonance solution procedure. The poor local search ability and low convergence speed of the PSO algorithm are ameliorated based on a particle distance index. The results show that the divergence is effectively avoided and the stability of the iterative algorithm is improved accordingly. The iteration speed is also improved by adding the inertial weight degradation strategy to PSO.

We would like to thank all the authors and reviewers for their invaluable contributions to the Special Section on Complex System Health Management Based on Condition Monitoring and Test Data. We believe the research articles included in this Special Section offer some new insights into the complex system reliability and prognostics, and will benefit both academia and industry through the research and development on the complex system reliability and prognostics. Specifically, we would like to thank the Editor-in-Chief, Professor Michael Pecht, for giving us the opportunity to organize this Special Section.

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