

# **2019 IEEE International Conference on Prognostics and Health Management (ICPHM 2019)**

**San Francisco, California, USA  
17 – 20 June 2019**



**IEEE Catalog Number: CFP19PHM-POD  
ISBN: 978-1-5386-8358-3**

**Copyright © 2019 by the Institute of Electrical and Electronics Engineers, Inc.  
All Rights Reserved**

*Copyright and Reprint Permissions:* Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

For other copying, reprint or republication permission, write to IEEE Copyrights Manager, IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. All rights reserved.

***\*\*\* This is a print representation of what appears in the IEEE Digital Library. Some format issues inherent in the e-media version may also appear in this print version.***

IEEE Catalog Number:	CFP19PHM-POD
ISBN (Print-On-Demand):	978-1-5386-8358-3
ISBN (Online):	978-1-5386-8357-6

**Additional Copies of This Publication Are Available From:**

Curran Associates, Inc  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: (845) 758-0400  
Fax: (845) 758-2633  
E-mail: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

CURRAN ASSOCIATES INC.  
**proceedings**  
.com

Monday, June 17

Monday, June 17 8:30 - 10:00

M.A.1: Tutorial: Using Fractional Failure for Reliability Assessment under Uncertainty

Dr. Feng-Bin (Frank) Sun

Room: Cypress A

Chair: Steven Li

M.B.1: Tutorial: Dimensionality Reduction Theories for PHM

Dr. Yixiang Huang

Room: Cypress B

Chair: Jie Liu

M.C.1: Tutorial: The Virtual SME (Subject Matter Expert): Enhanced Asset Monitoring with Automated Diagnostics

Dr. Randy Bickford

Room: Cypress C

Chair: Christian Hansen

Monday, June 17 10:30 - 12:00

M.A.2: Tutorial: Key Ingredients of Intellectual Property

Dr. Bill Tonti

Room: Cypress A

Chair: Steven Li

M.B.2: Tutorial: Fault Detection, Diagnosis, & Prognosis towards Autonomous Health Management and Maintenance Optimization for Rail Vehicle Systems

Dr. Gang Niu

Room: Cypress B

Chair: Jie Liu

M.C.2: Tutorial: Design Principles for Robust and Reliable Inverter Power Drives

Dr. Antonio Ginart

Room: Cypress C

Chair: Christian Hansen

Monday, June 17 13:00 - 14:30

M.A.3: Data-driven methods for PHM

Room: Cypress A

Chair: Meng Ma

**Remaining Useful Life Estimation Using Functional Data Analysis.....1**

Qiyao Wang, Shuai Zheng, Ahmed Farahat, Susumu Serita and Chetan Gupta

**A Parameter Adaptive Date Driven Approach for Remaining Useful Life Prediction of Solenoid valves.....9**

Xuanheng Tang, Jun Peng, Bin Chen, Fu Jiang, Yingze Yang, Rui Zhang, Dianzhu Gao, Xiaoyong Zhang and Zhiwu Huang

**Deep Recurrent Convolutional Neural Network for Remaining Useful Life Prediction.....15**

Meng Ma, Anqi He and Zhu Mao

**Fault Detection and Isolation in Industrial Networks using Graph Convolutional Neural Networks.....19**  
Hamed Khorasgani, Arman Hasanzadeh Moghimi, Ahmed Farahat and Chetan Gupta

## M.B.3: Time Series Analysis

Room: Cypress B

Chair: Fengbin (Frank) Sun

**Online change detection in time series: An overview.....26**  
Bernadin Namooano, A Starr and Christos Emmanouilidis

**Fault Detection and Classification of Time Series Using Localized Matrix Profiles.....36**  
Jing Zhang, Dan Nikovski, Teng-Yok Lee and Tomoya Fujino

**A One-Class Support Vector Machine Calibration Method for Time Series Change Point Detection.....43**  
Baihong Jin, Yuxin Chen, Dan Li, Kameshwar Poola and Alberto Sangiovanni-Vincentelli

**High-Accuracy Unsupervised Fault Detection of Industrial Robots Using Current Signal Analysis.....48**  
Fangzhou Cheng, Ajay Raghavan, Deokwoo Jung, Yukinori Sasaki and Yosuke Tajika

## M.C.3: Advanced Signal Processing for PHM

Room: Cypress C

Chair: Hansi Jiang

**Generating Real-valued Failure Data for Prognostics Under the Conditions of Limited Data Availability.....56**  
Gishan Don Ranasinghe and Ajith Kumar Parlikad

**Transferring Random Samples in Actuator Systems for Binary Damage Detection.....64**  
Tyler Cody

**Visual explanation of neural network based rotation machinery anomaly detection system.....71**  
Mao Saeki, Jun Ogata, Masahiro Murakawa and Tetsuji Ogawa

**Data-driven Prognosis of Fatigue-induced Delamination in Composites using Optical and Acoustic NDE methods.....75**  
Portia Banerjee, Yiming Deng, Lalita Udpa, Rajendra Prasath Palanisamy and Mahmoodul Haq

Monday, June 17 15:00 - 16:30

## M.A.4: Advanced Prognostics Methods & Application

Room: Cypress A

Chair: Meng Ma

**Quantifying the Impact of Prognostic Distance on Average Cost per Cycle.....85**  
Saikath Bhattacharya, Lance Fiondella, Saurabh Saxena and Michael Pecht

**Data-driven prognostics of remaining useful life for milling machine cutting tools.....92**  
Liu Yen Chun, Yuan-Jen Chang, Sheng-Liang Liu and Szu-Ping Chen

**An Operation Condition-Matched Similarity Method for Remaining Useful Life Estimation with Dynamic Sample Fusion.....97**  
Yuxuan Yang, Zhanbao Gao, Shu Zhang and Xulong Li

## M.B.4: Gearbox Diagnosis & Prognosis

Room: Cypress B

Chair: Fisseha Alemayehu

**Load sharing analysis of compound planetary gear set with cracked sun gear.....106**  
Guoyan Li, Linkai Niu, Liang Ma and Dehao Dong

**Early gear tooth crack detection based on singular value decomposition.....112**  
Ming Jian Zuo and Yuejian Chen

***Unsupervised Anomaly Detection Using Variational Auto-Encoder based Feature Extraction.....118***

Rong Yao, Chongdang Liu, Linxuan Zhang and Peng Peng

***Gearbox Fault Diagnostics Using Deep Learning with Simulated Data.....125***

Stephen Ekwaro-Osire, Ozhan Gecgel, João Paulo Dias, Abdul Serwadda, Fisseha Alemayehu and Abraham Nispel

## M.C.4: Big Data in PHM

Room: Cypress C

Chair: Hansi Jiang

***NDE 4.0: Smart NDE.....133***

[Debejyo Chakraborty](#) and Megan E. McGovern

***Fault Recognition Technology for Pipeline Systems Based on Multi-feature Fusion of Monitoring Data.....141***

Hongquan Jiang, Jianmin Gao, Fengshe Xia, Xiaoming Zhang, Tao Zhou and [Dongcheng Liu](#)

***Building the Tower of Babel for Big Data.....148***

[Adnan Mian](#) and [Richard B Ronson](#)

Tuesday, June 18

Tuesday, June 18 8:30 - 8:40

Conf. Opening: Conference Opening

Dr. Jie (Peter) Liu

Room: Sequoia A

Tuesday, June 18 8:40 - 9:40

Keynote: What comes after Prognostic

Dr. Kai Goebel

Room: Sequoia A

Tuesday, June 18 10:00 - 11:00

Keynote: Structural Health Monitoring from Diagnostics to Prognostics

Dr. Fu-Kuo Chang

Room: Sequoia A

Tuesday, June 18 11:00 - 12:00

Keynote: Industrial AI for Maintenance and Repair: Recent Advances and New Applications

Dr. Chetan Gupta

Room: Sequoia A

Tuesday, June 18 13:00 - 14:30

T.A.1: RUL Prediction

Room: Cypress A

Chair: Houman Hanachi

- An Improved Particle Filter Method for Accurate Remaining Useful Life Prediction.....156**  
Huang Dengshan, Meinan Wang, Shuai Zhao, Pengfei Wen, Shaowei Chen and Zhi Dou
- Remaining useful life Prediction of air spring.....164**  
[Farzaneh Ahmadzadeh](#), [Siahrood](#), Jonas Biteus and Olof Steinert
- Data-Driven Model Selection Study for Long-Term Performance Deterioration of Gas Turbines.....169**  
Yuan Liu, Avisekh Banerjee, Houman Hanachi and Amar Kumar

## T.B.1: Maintenance & Condition Monitoring

Room: Cypress B

Chair: Hasan Ferdowsi

- A New Anomaly Detection Method Based on Multi-dimensional Condition Monitoring Data for Aircraft Engine.....177**  
Shaowei Chen, Meng Wu, Shuai Zhao, Pengfei Wen, Huang Dengshan and Yan Wang
- A Measurement Frequency Estimation Method for Failure Prognosis of an Automated Tire Condition Monitoring System.....184**  
[Robert Meissner](#), Hendrik Meyer and Florian Raddatz
- Fault Detection and Estimation for a Class of Nonlinear Distributed Parameter Systems.....192**  
[Hasan Ferdowsi](#), Jia Cai and Sarangapani Jagannathan

## T.C.1: AI for PHM

Room: Cypress C

Chair: Yongzhi Qu

- A Novel Bayesian Update Method for Parameter-Reconstruction of Remaining Useful Life Prognostics.....200**  
Pengfei Wen, Shaowei Chen, Shuai Zhao, Li Yong, Yan Wang and Zhi Dou
- Detecting and Diagnosing Incipient Building Faults Using Uncertainty Information from Deep Neural Networks.....208**  
[Baihong Jin](#), Dan Li, Seshadhri Srinivasan, See-Kiong Ng, Kameshwar Poola and Alberto Sangiovanni-Vincentelli
- Remaining Useful Life Estimation by Empirical Mode Decomposition and Ensemble Deep Convolution Neural Networks.....216**  
Yao QingFeng, Yang Tianji, Liu Zhi and Zeyu Zheng

Tuesday, June 18 15:00 - 16:30

## T.A.2: Battery Prognostics

Room: Cypress A

Chair: Rui Zhao

- An Aging-Aware SOC Estimation Method for Lithium-Ion Batteries using XGBoost Algorithm.....222**  
Fu Jiang, Jiajun Yang, Yijun Cheng, Xiaoyong Zhang, Yingze Yang, Kai Gao, Jun Peng and Zhiwu Huang
- A Hybrid Deep Learning Based Approach for Remaining Useful Life Estimation.....230**  
David He and [Khaled Akkad](#)
- Diagnosis of Membrane Chemical Degradation For Health Management of Polymer Electrolyte Fuel Cells.....236**  
[Derek Low](#)

## T.B.2: PHM for Wind Turbine

Room: Cypress B

Chair: Fisseha Alemayehu

- Degradation Estimation of Turbines in Wind Farm Using Denoising Autoencoder Model.....244**  
[Shuichi Sato](#)
- Generating Mathematical Model of Equipment and Its Applications in PHM.....250**  
[Pushu Zhao](#), Masaru Kurihara, Tojiro Noda, Hiroki Kashiwa and Masaki Hiyama

## T.C.2: Recent PHM Advances and Applications in Aerospace Engineering

Room: Cypress C

Chair: Yongzhi Qu

- Research on General Aircraft Cluster Health Assessment Method.....257**  
Guigang Zhang
- Diagnosing Strong-fault Models with a Two-step A\* Search Method.....263**  
Qi Zhao, Wenfeng Zhang, Yuhao Deng, Hongbo Zhao and Wenquan Feng
- An Adaptive Fault Diagnosis System Framework for Aircraft Based on Man-in-loop.....271**  
Guigang Zhang

## Wednesday, June 19

### Wednesday, June 19 8:30 - 10:00

#### W.A.1: Electronics PHM

Room: Cypress A

Chair: Houman Hanachi

- Diagnosis Method for Hydro-generator Rotor Fault Based on Stochastic Resonance.....275**  
Junqing Lee, Luo Wang and Yonggang Li
- Essentials to Develop Data-Driven Predictive Models of Prognostics and Health Management for Distributed Electrical Systems.....280**  
Farhad Balali, Hamid Seifoddini and Adel Nasiri
- Faults Analysis of Double Water Inner Cooled Synchronous Machines.....288**  
Andong Wang, Junqing Lee, Yangshuo Ma and Fuchun Sun

#### W.B.1: PHM Algorithm

Room: Cypress B

Chair: Gang Niu

- A Data-Based Approach for Sensor Fault Detection and Diagnosis of Electro-Pneumatic Brake.....295**  
Yunyou Lu, Xiaoping Fan, Dianzhu Gao, Yijun Cheng, Yingze Yang, Xiaoyong Zhang, Shuo Li and Jun Peng
- Multi-model Gaussian Process-based Remaining Useful Life Prediction.....301**  
Meng Li, Mohammadkazem Sadoughi, Sheng Shen and Chao Hu

#### W.C.1: PHM for Transportation

Room: Cypress C

Chair: Michael Azarian

- Prognostics of polygonalization of high-speed railway (HSR) train wheels using a generalized additive model (GAM) smoothed by spline-backfitted kernel.....307**  
Zhexiang Chi
- Wheel Polygonalization Identification Method Based on Fluctuation of Temperature Data and Wheel Set Dynamic Monitoring Data.....312**  
Zejun Zheng, Dongli Song, Zilin Geng, Xiaoyue Qi and Weihua Zhang
- Electronic Circuit Diagnosis with No Data.....317**  
Varun Khemani, Michael H Azarian and Michael Pecht

### Wednesday, June 19 10:30 - 12:00

#### W.A.2: Structural Diagnostics & Prognostics

Room: Cypress A

Chair: Yongzhi Qu

- An FBG Based Smart Clamp Fabricated by 3D Printing Technology and Its Application To Incipient Clamp Looseness Detection.....324**  
Zechao Wang, Mingyao Liu, [Yongzhi Qu](#), Qin Wei, Zude Zhou, Liu Hong, Yuegang Tan and Jun Zhang
- Research on the Propagation of Defects in Assembly Process Based on SIR Epidemic Model.....334**  
[Mengyao Wu](#) and Wei Dai
- Estimating remaining useful life of machine tool ball screws via probabilistic classification.....340**  
[Maximilian Benker](#)

## W.B.2: Physics-based Models in Prognostics

Room: Cypress B

Chair: Gang Niu

- Predicting Time-to-Failure of Plasma Etching Equipment using Machine Learning.....347**  
Seyedeh Anahid Naghibzadeh-Jalali, Clemens Heistracher, Alexander Schindler, Bernhard Haslhofer, Tanja Nemeth, Robert Glawar, Wilfried Sihh and Peter De Boer
- A Physics based prognostics approach for Tidal Turbines.....355**  
Fraser Ewing
- Differentiation of Journal Bearing Friction States under varying Oil Viscosities based on Acoustic Emission Signals.....362**  
Noushin Mokhtari, Clemens Guehmann, Sebastian Nowoisky, René Knoblich and José-Luis Bote-Garcia

## W.C.2: Data-Driven PHM Methods

Room: Cypress C

Chair: Michael Azarian

- A Comparative Study of Deep Learning-Based Diagnostics for Automotive Safety Components Using a Raspberry Pi.....369**  
[Namkyoung Lee](#), Michael H Azarian, Michael Pecht, Jinyong Kim and Jongsoon Im
- Unsupervised Fault Detection in Varying Operating Conditions.....376**  
Gabriel Michau and Olga Fink
- Health Assessment for Crane Pumps based on Vehicle Tests using Deep Autoencoder and Metric Learning.....386**  
Dengyu Xiao, Yixiang Huang, Chengjin Qin, Haotian Shi, Chengliang Liu and Zenghai Shan

Wednesday, June 19 13:00 - 14:30

## W.A.3: Bearings Prognostics

Room: Cypress A

Chair: Wendai Wang

- Calculating the Contact Forces at Imperfect Surfaces Considering Elastohydrodynamic Lubrication Effects in Rolling Element Bearings.....392**  
Linkai Niu, Fengtao Wang, Guoyan Li, Chenguang Niu, Yuan Lan and Xiaoyan Xiong
- A Novel Bearing Health Indicator Construction Method Based on Ensemble Stacked Autoencoder.....398**  
[Pengfei Lin](#) and Jizhong Tao
- A Deep Learning Approach for Failure Prognostics of Rolling Element Bearings.....407**  
Mohammadkazem Sadoughi, Hao Lu and Chao Hu

## W.B.3: Bearings Fault Diagnosis

Room: Cypress B

Chair: Hubert Razik

- Intelligent Fault Diagnosis of Rolling Element Bearing Based on Convolutional Neural Network and Frequency Spectrograms.....414**  
[Pengfei Liang](#), Chao Deng, Jun Wu, Zhixin Yang and Jinxuan Zhu



**Vibration feature extraction using local temporal self-similarity for rolling bearing fault diagnosis.....419**

Shichen Zeng, Guoliang LU and Peng Yan

**Construction and Application of Failure Prediction and Health Management System for Bearing of Running Gear of Rolling Stock.....424**

Hongzhi Song, Li Li, Xingkuan Yang and Zhenzhong Fan

### W.C.3: General Topic

Room: Cypress C

Chair: Anne Kao

**Part Name Normalization.....430**

Nobal Niraula, Anne Kao and Daniel Whyatt

**Formulation and Solution for the Predictive Maintenance Integrated Job Shop Scheduling Problem.....436**

Simon Zhai

**Implementing Predictive Maintenance in a Company: Industry Insights with Expert Interviews.....444**

Carolin Wagner and Bernd Hellingrath

## Wednesday, June 19 15:00 - 16:30

### W.A.4: Reliability and PHM

Room: Cypress A

Chair: Guoliang LU

**Data-Informed Lifetime Reliability Prediction for Offshore Wind Farms.....452**

Alexios Koltzidopoulos Papatzimos, Philipp R. Thies, Jerome Lonchamp, Antoine Joly and Tariq Dawood

**Dynamic Programming for Multi-Stage Reliability Growth Planning.....460**

Dong Xu and Steven Li

### W.B.4: Fault Diagnosis Approaches

Room: Cypress B

Chair: Hubert Razik

**Fault Diagnosis of Lubrication System in Internal Combustion Engine.....466**

Azeem Sarwar and Syed Mehdi

**A novel unsupervised anomaly detection for gas turbine using Isolation Forest.....474**

Fu Song, Shisheng Zhong, Lin Lin, Fu Xu-yun, Zhiquan Cui and Rui Wang

**Application of Deep Learning for Fault Diagnostic in Induction Machine's Bearings.....480**

Nastaran Enshaei and Farnoosh Naderkhani

### W.C.4: General Topic

Room: Cypress C

Chair: Christian Hansen

**A Multivalued Test and Diagnostic Strategy Optimization Method for Aircraft System Fault Diagnosis.....487**

Yan Su

**Operating state evaluation of smart electricity meter based on data fusion method.....493**

You LI

**Distributed Computational Architecture for Industrial Motion Control and PHM Implementation.....501**

Shrinivas Kulkarni, Anirban Guha, Suhas Dhakate and Milind T. r.