Call for Paper of Special Issue on "Advanced Soft Computing for Prognostic Health Management" in Applied Soft Computing

Mahardhika Pratama, Edwin Lughofer, Suresh Sundaram, Moamar Sayed Mouchaweh, Igor Škrjanc, Fahed Mostafa

Aims and Scope:

Prognostic health management (PHM), studying machine failure detection and management of its life-cycle, is a research area of growing interest because of the economic cost associated with undiagnosed machine failure [1]. A complex manufacturing plant usually consists of a number of massive inter-related components. A failure of a particular component frequently imposes a complete shutdown of the plant process meaning a complete stop of the production cycle. An equipment failure imposes millions of dollars in costs for repair materials, labour and interruption of production cycles, since components are manufactured half way across the world and there may only be few places where they are manufactured. Aging of machinery and its components makes machinery vulnerable to failures. This problem cannot be completely addressed by regular maintenance, carried out at pre-scheduled time periods and requires "maintenance on-demand", during the specific time period, when the machine is likely to fail [2]. The optimization of machinery service and the minimization of life-cycle costs demand advanced soft computing approaches to predict when a machine will no longer be able to perform with satisfactory functionality as well as to monitor a machine condition while running the process without interruption and to alert operators when a fault comes into picture.

Prognostics or prediction of the remaining useful life (RUL) plays a crucial role in PHM to provide accurate decision support for maintenance on-demand [5]. While fault detection has been well researched, the prognostics of the likely occurrence of a fault before it occurs has recently started to be a major focus of investigation. Note that accurate prediction of a machinery's RUL leads to flexibility of maintenance on demand such as advanced scheduling of maintenance activities, proactive allocation of replacement parts and enhanced fleet deployment decisions based on the estimated progression of component life consumption. The prediction of RUL aims to make use of the monitoring information of in-service machinery and its past operation profile in order for RUL to be identified before a failure occurs. Nonetheless, development of a reliable predictive methodology to feed accurate information of lifetime of machinery or to monitor tool condition in real-time remains a very complex issue to be dealt with due to the following challenges:

(R1) *Online Real-Time Requirement*: Industrial processes often run in the high speed and are supposed to run without any interruption. Consequently, data are captured by sensor in a very high sampling rate, leading to an explosion of data volume over period of time. This issue requires an online real-time algorithm, which features a rapid training process. Furthermore, the algorithm should be capable of efficiently processing data streams in the single-pass mode. That is, only the newest data stream is seen in any given step without revisiting preceding data streams. Once learned, data are directly discarded. This strategy allows to bring down data storage requirement to a low level, which is independent from the data volume [3].

(R2) *Evolving and Adaptive Requirement*: The process's environment, weather conditions, load conditions, or its internal states are rapidly changing because of varying machining parameters, and the inconsistency and variability of cutter geometry/dimensions. This issue entails a flexible and autonomous learning algorithm, which adapts to any variations of data streams or concept drifts with minimum operator supervision. The algorithm should be capable of distinguishing whether the concept change is intentional or not and should not be confused

with possibility of outliers due to noisy characteristic of sensory data. This algorithm can start its learning process from scratch from an empty rule-base or an initially trained network structure and can then self-organize and self-evolve its network structure on the fly referring to up-to-date data distribution and degree of nonlinearity of a system being modelled. In other words, the learning algorithm is capable of dealing with online life-long learning scenario [4].

(R3) *Robustness against Complex Real-World Data Requirement*: Real-world manufacturing data are usually biased from their true representation as a result of noisy environments, inaccurate measurements, false sensor reading, faulty sensor, etc. which make accurate, exact and precise assumptions of data infeasible. It is often found that data are incomplete and contain missing features and values. This issue calls for robustness against uncertain data requirement which enables a reliable decision to be made from inexact or even qualitative sources of knowledge. Data analytics must be fault-tolerant and be robust to outliers. They should detect anomalies of production data to alarm an operator to undertake preventive actions against unsafe operating conditions. Furthermore, real-word production data are often in a high dimension [5] because of deployment of multi sensors, multi-dimensional cutting axes, lagged input attributes, etc. A feature selection mechanism should be carried out to find a low dimensional space which still retains the original input information as much as possible. The feature selection process in the pre-processing utilizing prerecorded data or in the batch mode, however, is not relevant in the online real-time situation since it does not cope with a fast sampling rate of a high-speed machining process, which highly relies on prognostic and predictive tools to achieve greater efficiency.

This special issue aims to bring together research works of soft computing including but not limited to metaheuristic, fuzzy system, neural system, hybrid and probabilistic systems with application to the PHM. Special attention will be paid toward algorithmic development of advanced soft computing to address advanced issues of PHM in various application domains.

References:

[1] K. Javed, R. Gouriveau, N. Zerhouni, "A New Multivariate Approach for Prognostics Based on Extreme Learning Machine and Fuzzy Clustering", IEEE Transactions on Cybernetics, Vol. 45(12), pp. 2626-2639, 2015

[2] S. N. Omkar, J. Senthilnath and S. Suresh, "Mathematical model and rule extraction for tool wear monitoring problem using nature inspired techniques," Indian Journal of Engineering and Materials Sciences, vol. 16, no. 4, pp. 205-210, 2009

[3] M.Pratama, M-J.Er, X.Li, R.J.Oentaryo, E.Lughofer, I.Arifin, "Data-Driven Modelling Based on Dynamic Parsimonious Fuzzy Neural Network", Neurocomputing, Vol.110, pp.18-28, 2013, 2013

[4] H Toubakh, M Sayed-Mouchaweh, "Hybrid dynamic classifier for drift-like fault diagnosis in a class of hybrid dynamic systems: Application to wind turbine converters", Neurocomputing, Vol. 171, pp. 1496-1516, 2016

[5] F. Serdio, E. Lughofer, K. Pichler, M. Pichler, T. Buchegger and H. Efendic, "Fuzzy Fault Isolation using Gradient Information and Quality Criteria from System Identification Models", Information Sciences, vol. 316, pp. 18-39, 2015

Topics:

The main topics of this special session include, but are not limited to, the following: [Basic Methodologies]

- Advanced soft computing for fault detection and diagnosis
- Advanced soft computing for tool condition monitoring

- Advanced soft computing for estimation of tool's remaining useful life

[Advanced Concepts]

- Appropriate handling of data uncertainty in various forms in PHM
- Data stream analytics for PHM
- Big data analytics for PHM
- Techniques to address drifts and shifts for PHM
- On-line dynamic dimension reduction for PHM
- Feature selection and extraction techniques for PHM
- Sample selection and active learning for PHM
- Reliability in model predictions and parameters for PHM
- Domain adaptation, importance weighting and sampling for PHM
- Parameter-low and –insensitive learning methods for PHM
- On-line complexity reduction to emphasize transparent, more compact models for PHM
- Unsupervised approach for PHM
- Anomaly detection for PHM
- Outlier detection for PHM
- Noise Cancellation for PHM

[Applications]

- Complex manufacturing process
- Data stream modelling and identification (supervised and unsupervised)
- Online fault detection and decision support systems
- Online media stream classification
- Predictive maintenance and prognostics
- Fault isolation
- Process control and condition monitoring
- Modelling in high throughput production systems
- Adaptive chemometric models in dynamic chemical processes
- High-speed machining process
- Robotics, Intelligent Transport and Advanced Manufacturing
- Optimization of complex manufacturing systems
- Feedback control systems
- Intelligent Control Systems

Tentative Key dates and Submissions

- First Submission Date: June 1st, 2017
- Paper submission deadline: October 1st, 2017
- Submission of revised paper: March 31st , 2018
- Notification of acceptance: June 30th, 2018
- Publication expected date: October 1st, 2018

Papers will be evaluated based on their originality, presentation as well as relevance and contribution to the fields of PHM and soft computing, suitability to the special issue, and overall quality. All papers will be rigorously refereed by 3 peer reviewers. Submission of a manuscript to this special issue implies that no similar paper is already accepted or will be submitted to any other journal.

Authors should consult the "Guide for Authors", which is available online at https://www.elsevier.com/journals/applied-soft-computing/1568-4946/guide-for-authors, for information about preparation of their manuscripts. Manuscripts should be submitted via the Elsevier Editorial System https://www.journals.elsevier.com/applied-soft-computing/.

IMPORTANT: Please choose "**SI: PHM**" when specifying the Article Type.

Guest Editors:

1. Asst. Prof. Mahardhika Pratama, Nanyang Technological University, Singapore
2. Dr. Edwin Lughofer, Johannes Kepler University, Austria
3. Assoc. Prof. Suresh Sundaram, Nanyang Technological University, Singapore
4. Prof. Moamar Sayed Mouchaweh, Ecole des Mines de Douai, France
5. Prof. Igor Škrjanc, University of Ljubljana, Slovenia
6. Dr. Fahed Mostafa, Incitec Pivot Limited, Australia

Guest Editors Biodata:

Dr. Mahardhika Pratama received his PhD degree from the University of New South Wales, Australia in 2014. He completed his PhD in 2.5 years with a special approval of the UNSW higher degree committee due to his outstanding PhD research achievement. Dr. Pratama is a faculty member at the School of Computer Science and Engineering, Nanyang Technological University, Singapore. He worked as a lecturer at the Department of Computer Science and IT, La Trobe University from 2015 till 2017. Prior to joining La Trobe University, he was with the Centre of Quantum Computation and Intelligent System, University of Technology, Sydney as a postdoctoral research fellow of Australian Research Council Discovery Project. Dr. Pratama received various competitive research awards in the past 5 years, namely the Institution of Engineers, Singapore (IES) Prestigious Engineering Achievement Award in 2011, the UNSW high impact publication award in 2013 and 2014. Dr. Pratama has published over 56 high-quality papers in journals and conferences and edited one book, and has been invited to deliver keynote speeches in international conferences. Dr. Pratama has led four special sessions and one special issue in prestigious conferences and journals. He currently serves as an editor in-chief of International Journal of Business Intelligence and Data Mining. Dr. Pratama is a member of IEEE, IEEE Computational Intelligent Society (CIS) and IEEE System, Man and Cybernetic Society (SMCS), and Indonesian Soft Computing Society (ISC-INA). His research interests involve machine learning, computational intelligent, evolutionary computation, fuzzy logic, neural network and evolving adaptive systems.

Dr. Edwin Lughofer received his PhD. degree from the Department of Knowledge-Based Mathematical Systems, Johannes Kepler University Linz, where he is now employed as senior/key researcher. During the past 10-12 years, he has participated in several research projects on European and national level. In this period, he has published around 130 journal and conference papers in the fields of evolving fuzzy systems, machine learning and vision, data stream mining, active learning, classification and clustering, fault detection and diagnosis, condition monitoring as well as human-machine interaction, including a monograph on 'Evolving Fuzzy Systems' (Springer, Heidelberg) and an edited book on 'Learning in Non-stationary Environments' (Springer, New York). He is associate editor of the international journals IEEE Transactions on Fuzzy Systems (IEEE press), Evolving Systems (Springer), Information Fusion (Elsevier) and Soft Computing (Springer), the general chair of the IEEE Conference on Evolving and Adaptive Intelligent Systems 2014 and Area chair of the FUZZ-IEEE 2015 conference in Istanbul. He serves as program committee member of several international conferences, and acts as a peer-reviewer for 20+international journals. In 2006 he received the best paper award (as main author) at the International Symposium on Evolving Fuzzy Systems, and in 2013 the best paper award (as co-author) at the IFAC conference in Manufacturing Modeling, Management and Control Conference (800 participants).

A/Prof. Suresh Sundaram received his B.E degree in electrical and electronics engineering from Bharathiyar University in 1999, and M.E (2001) and Ph.D (2005) degrees in Department of Aerospace Engineering from Indian Institute of Science Bangalore, INDIA. He was post-doctoral researcher in School of Electrical Engineering, Nanyang Technological University, Singapore, from 2005-2007. Subsequently, He was selected as a ERCIM research fellow for the period of 2007-2008 and spent valuable time in the project team PULSAR at INRIA Sophia-Antipolis, France. For a short period, Prof. Suresh was working as Faculty at Industrial Engineering, Korea University, Seoul. Later, He was with Indian Institute of Technology - Delhi, as an Assistant Professor in Electrical Engineering from 2008-2009. From 2010, Prof. Suresh am working as Associate Professor in School of Computer Engineering, Nanyang Technological University, Singapore.

Prof. Moamar Sayed Mouchaweh is working as a Full Professor in the High National Engineering School of Mines "Ecole Nationale Supérieure des Mines de Douai" at the Department of Automatic Control and Computer Science (Informatique & Automatique IA). He edited the Springer Book « Learning in Non-Stationary Environments: Methods and Applications », April 2012 and wrote two Brief Springer books 'Discrete Event Systems: Diagnosis and Diagnosability' and 'Learning from Data Streams in Dynamic Environments'. He served as International Program Committee chair and member for several International Conferences as well as a member in IEEE and IFAC technical committees. He also (co-) organized several special issues and sessions and presented several tutorials. He is working as a member of the Editorial Board of Elsevier Journal "Applied Soft Computing", Springer Journals "Evolving systems" and "Intelligent Industrial Systems" and InderScience Journal "International Journal of Business Intelligence and Data Mining".

Prof. Igor Škrjanc received the B.Sc., the M.Sc. and the Ph.D. degrees in electrical engineering, in 1988, 1991 and 1996, respectively, from the Faculty of Electrical and Computer Engineering, University of Ljubljana, Slovenia. His main research interests are in adaptive, predictive, fuzzy and fuzzy adaptive control systems. This was also the title of his Ph.D. thesis. In 2007 he received the highest research award of the Faculty of Electrical Engineering, Vodovnikova award and in 2008, award of the Republic of Slovenia for Scientific and Research Achievements (awarded by Government of the Republic of Slovenia), Zois award for outstanding research results in the field of intelligent control. He also received the Humboldt Research Fellowship for Experienced Researchers for the period between 2009-2011 for the research work at University of Siegen.

Dr. Fahed Mostafa is an Honorary visiting fellow at La Trobe university. His research interest include predictive maintenance, manufacturing process optimization and financial risk management. He is currently a member of IEEE IES TCII (TCII Sub-Committee Chair on Data Science). Fahed has over 15 years of industry experience in managing large SAP landscapes and business analytics teams. He is currently the Data Analytics manager at Incitec Pivot Limited.