

Dear SHRM Newsletter Subscribers

Greetings and Welcome to our SHRM newsletter!
In this edition we are pleased to deliver highlights of SHRM member activities From May 2019 to May 2020.
This newsletter features the wide-ranging scholarly and professional activities of current and former SHRM members, including notable achievements in both research and education activities.

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- 1 New Journal Papers / Awards / Patents
- 2 Project Updates
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1 New Journal Papers / Awards / Patents

Journal Papers (22 Published, 1 Accepted, 12 submitted)

22 papers were published and 1 paper was accepted for publication in highly ranked journals. In addition, 12 papers are submitted. Progress on these papers will be reported in a future newsletter.

Published or Accepted

1) Soo-Ho Jo, Heonjun Yoon, Yong Chang Shin, and Byeng D. Youn, "A Graded Phononic Crystal with Decoupled Double Defects for Broadband Energy Localization," International Journal of Mechanical Sciences, v183, p105833, 2020-10

- 2) Soo-Ho Jo, Heonjun Yoon, Yong Chang Shin, Wonjae Choi, Choon-Su Park, Miso Kim, and Byeng D. Youn, "Designing a Phononic Crystal with a Defect for Energy Localization and Harvesting: Supercell Size and Defect Location," *International Journal of Mechanical Sciences*, v179, pp105670, 2020-08
- 3) Minji Yoo, Taejin Kim, Joung Taek Yoon, Yunhan Kim, Sooho Kim, and Byeng D. Youn, "A Resilience Measure Formulation that Considers Sensor Faults," *Reliability Engineering & System Safety*, v199, pp106393, 2020-07
- 4) Soo-Ho Jo, Boseong Seo, Hyunseok Oh, Byeng D. Youn, and Dongki Lee, "Model-Based Fault Detection Method for Coil Burnout in Solenoid Valves Subjected to Dynamic Thermal Loading," *IEEE Access*, v8, pp70387-70400, 2020-04
- 5) Soo-Ho Jo, Heonjun Yoon, Yong Chang Shin, Miso Kim, and Byeng D. Youn, "Elastic Wave Localization and Harvesting Using Double Defect Modes of a Phononic Crystal," *Journal of Applied Physics*, v127, n16, pp164901, 2020-04
- 6) Byung Chul Jeon, Joon Ha Jung, Myungyon Kim, Kyung Ho Sun, and Byeng D. Youn, "Optimal Vibration Image Size Determination for Convolutional Neural Network Based Fluid-film Rotor-bearing System Diagnosis," *Journal of Mechanical Science and Technology*, v34, pp1467-1474, 2020-04
- 7) Hyejeong Son, Guesuk Lee, Kyeonghwan Kang, Young-jin Kang, Byeng D. Youn, Ikjin Lee, and Yoojeong Noh, "Industrial Issues and Solutions to Statistical Model Improvement: A Case Study of an Automobile Steering Column," *Structural and Multidisciplinary Optimization*, v61, pp1739-1756, 2020-04
- 8) Yunhan Kim, Jungho Park, Kyumin Na, Hao Yuan, Byeng D. Youn, and Chang-soon Kang, "Phase-Based Time Domain Averaging (PTDA) for Fault Detection of a Gearbox in an Industrial Robot Using Vibration Signals," *Mechanical Systems and Signal Processing*, v138, pp106544, 2020-04
- 9) Junpeng Zhao, Heonjun Yoon, and Byeng D. Youn, "An Adaptive Hybrid Expansion Method (AHM) for Efficient Structural Topology Optimization under Harmonic Excitation," *Structural and Multidisciplinary Optimization*, v61, pp895-921, 2020-03
- 10) Wongon Kim, Heonjun Yoon, Guesuk Lee, Taejin Kim, and Byeng D. Youn, "A New Calibration Metric that Considers Statistical Correlation: Marginal Probability and Correlation Residuals," *Reliability Engineering & System Safety*, v195, pp106677, 2020-03
- 11) N.H.H.A.Talib, H.Salleh, Byeng D. Youn, and M.S.M.Resali, "Comprehensive Review on Effective Strategies and Key Factors for High Performance Piezoelectric Energy Harvester at Low Frequency," *International Journal of Automotive and Mechanical Engineering*, v16, n4, pp7181-7210, 2019-12
- 12) Taejin Kim and Byeng D. Youn, "Identifiability-based Model Decomposition for Hierarchical Calibration," *Structural and Multidisciplinary Optimization*, v60, n5, pp1801-1811, 2019-11
- 13) Dae Seong Woo, Changwoon Han, Byeng D. Youn, and Kyoung Joon Kim, "Thermal Modelling and Design of Dynamically-Controlled Heater Plates for High Temperature Processing of 300 mm Wafers," *Journal of Mechanical Science and Technology*, v33, n10, pp5009-5016, 2019-10
- 14) Junpeng Zhao, Heonjun Yoon, and Byeng D. Youn, "Concurrent Topology Optimization with Uniform Microstructure for Minimizing Dynamic Response in the Time Domain," *Computers & Structures*, v222, pp98-117, 2019-10

- 15) Guesuk Lee, Hyejeong Son, and Byeng D. Youn, "Sequential Optimization and Uncertainty Propagation Method for Efficient Optimization-Based Model Calibration," *Structural and Multidisciplinary Optimization*, v60, n4, pp1355-1372, 2019-10
- 16) Guesuk Lee, Wongon Kim, Hyunseok Oh, Nam H. Kim, and Byeng D. Youn, "Review of Statistical Model Calibration and Validation-From the Perspective of Uncertainty Structures," *Structural and Multidisciplinary Optimization*, v60, n4, pp1619-1644, 2019-10
- 17) Taejin Kim, Guesuk Lee, and Byeng D. Youn, "PHM Experimental Design for Effective State Separation using Jensen-Shannon Divergence," *Reliability Engineering & System Safety*, v190, pp106503, 2019-10
- 18) Hyunseok Oh, Hwanoh Choi, Joon Ha Jung, and Byeng D. Youn, "A Robust and Convex Metric for Unconstraint Optimization in Statistical Model Calibration – Probability Residual (PR)," *Structural and Multidisciplinary Optimization*, v60, n3, pp1171-1187, 2019-09
- 19) Asif Khan, Nayeon Kim, Jae Kyong Shin, Heung Soo Kim, and Byeng D. Youn, "Damage Assessment of Smart Composite Structures via Machine Learning: A Review," *Journal of Mechanical Science and Technology - Advances*, v1, n1-2, pp107-124, 2019-06
- 20) Moussa Hamadache, Joon Ha Jung, Jungho Park, and Byeng D. Youn, "A Comprehensive Review of Artificial Intelligence-Based Approaches to Rolling Element Bearing PHM: Shallow & Deep Learning," *Journal of Mechanical Science and Technology - Advances*, v1, n1-2, pp125-151, 2019-06
- 21) Guilian Yi, Yong Chang Shin, Heonjun Yoon, Soo-Ho Jo, and Byeng D. Youn, "Topology Optimization for Phononic Band Gap Maximization Considering a Target Driving Frequency," *Journal of Mechanical Science and Technology - Advances*, v1, n1-2, pp153-159, 2019-06
- 22) Useok Jeong, Keunsu Kim, Sang-Hun Kim, Hyunhee Choi, Byeng D. Youn, and Kyu-Jin Cho, "Reliability Analysis of a Tendon-Driven Actuation for Soft Robots," *International Journal of Robotics Research*, Online Published
- 23) Sooho Kim, Jin-Oh Hahn, and Byeng D. Youn, "Detection and Severity Assessment of Peripheral Occlusive Artery Disease via Deep Learning Analysis of Arterial Pulse Waveforms: Proof-of-Concept and Potential Challenges," *Frontiers in Bioengineering and Biotechnology*, Accepted

Submitted

- 1) Wongon Kim, Sunwue Kim, Jingyo Jeong, and Byeng D. Youn, "A Digital Twin Approach for Mechanical Health State Estimation of On-Load Tap Changers," *Mechanical Systems and Signal Processing*, Under Revision
- 2) Myeongbaek Youn, Yunhan Kim, Dongki Lee, Minki Cho, and Byeng D. Youn, "Fatigue Crack Length Estimation and Prediction using Trans-fitting with Support Vector Regression," *International Journal of Prognostics and Health Management*, Under Revision
- 3) Hyeon Bae Kong, Soo-Ho Jo, Joon Ha Jung, Jong M. Ha, Yong Chang Shin, Heonjun Yoon, Kyung Ho Sun, Yun-Ho Seo, and Byung Chul Jeon, "A Hybrid Approach of Data-driven and Physics-based Methods for Estimation and Prediction of Fatigue Crack Growth," *International Journal of Prognostics and Health Management*, Under Revision

- 4) Yong Chang Shin, Heonjun Yoon, Soo-Ho Jo, Wonjae Choi, Choon-Su Park, Miso Kim, and Byeng D. Youn, "Phononic Band Gap of a Quarter-wave Stack for Enhanced Piezoelectric Energy Harvesting," International Journal of Mechanical Sciences, Under Revision
- 5) Woosung Choi, Heonjun Yoon, and Byeng D. Youn, "Operation-Adaptive Damage Assessment of Steam Turbines Using a Nonlinear Creep-Fatigue Interaction Model," IEEE Access, Under Revision
- 6) Soo-Ho Jo, Yiwei Xia, Adriane G. Moura, Heonjun Yoon, Yong Chang Shin, Alper Erturk, and Byeng D. Youn, "Experimentally Validated Broadband Self-Collimation of Elastic Waves," Extreme Mechanics Letters, Under Revision
- 7) Junggho Park, Yunhan Kim, Kyumin Na, Byeng D. Youn, Yuejian Chen, Ming J. Zuo, and Yong-Chae Bae, "An Image-based Feature Extraction Method for Fault Diagnosis of Variable-speed Rotating Machinery," Mechanical Systems and Signal Processing, Submitted
- 8) Chan Hee Park, Hyunjae Kim, Junmin Lee, Giljun Ahn, Myeongbaek Youn, and Byeng D. Youn, "A Feature Inherited Hierarchical Convolutional Neural Network (FI-HCNN) for Motor Fault Severity Estimation Using Stator Current Signals," International Journal of Precision Engineering and Manufacturing - Green Technology, Submitted
- 9) Soo-Ho Jo, Heonjun Yoon, Yong Chang Shin, and Byeng D. Youn, "An Electroelastically Coupled Analytical Model of a Phononic Crystal with a Piezoelectric Defect," International Journal of Engineering Science, Submitted
- 10) Tae-Gon Lee, Soo-Ho Jo, Hong Min Seung, Sun-Woo Kim, Eun-Ji Kim, Byeng D. Youn, Sahn Nahm, and Miso Kim, "Enhanced Energy Transfer and Conversion for High Performance Phononic Crystal-Assisted Elastic Wave Energy Harvesting," Nano Energy, Submitted
- 11) Myungyon Kim, Jin Uk Ko, Jinwook Lee, Byeng D. Youn, Joon Ha Jung, and Kyung Ho Sun, "A Domain Adaptation with Semantic Clustering (DASC) Method for Fault Diagnosis of Rotating Machinery," ISA Transactions, Submitted
- 12) Jin Uk Ko, Joon Ha Jung, Myungyon Kim, Hyeon Bae Kong, Jinwook Lee, and Byeng D. Youn, "Multi-Task Learning of Classification and Denoising (MLCD) for Noise-Robust Rotor System Diagnosis" Computers in Industry, Submitted

Awards

10 awards were rewarded,
1 Front Cover as well as Featured Article, 3 Data Challenge Winner, 1 AI Competition Winner,
5 Best Paper/Presentation/Poster Awards from conferences.

Congratulation to all prize winners!



- 1) Soo-Ho Jo, Heonjun Yoon, Yong Chang Shin, Miso Kim, and Byeng D. Youn, Front Cover and Featured Article in Journal of Applied Physics, April, 2020



2) Myungyon Kim and Yunhan Kim, Encouragement Prize, Factory Hack Korea-Industrial AI Hackathon 2020, January, 2020



3) Yeongtak Oh, Yunhan Kim, Kyumin Na, and Byeng D. Yoon, Best Paper Award in International Conference on Materials and Reliability 2019(ICMR2019), December, 2019



4) Myeongbaek Youn, Yunhan Kim, Dongki Lee, and Minki Cho, 1st place winner in 2019 PHM Data Challenge Competition Organized by PHM Society, September, 2019



5) Hyeon Bae Kong, Soo-Ho Jo, Joon Ha Jung, Jong M. Ha, Yong Chang Shin, Heonjun Yoon, Kyung Ho Sun, Yun-Ho Seo, and Byung Chul Jeon, 2nd place winner in 2019 PHM Data Challenge Competition Organized by PHM Society, September, 2019



6) Myungyon Kim, Jongmin Park, Yongjin Shin, and Byeng D. Yoon, 3rd place winner in 2019 PHM Data Challenge Competition Organized by PHM Asia Pacific, July, 2019



7) Kyumin Na, Jungho Park, Yunhan Kim, and Byeng D. Yoon, Best Presentation Award in PHM KOREA 2019, April, 2019



8) Jong Keun Im, Boseong Seo, Yeong Hoon Son, Dongkyu Lee, and Byeng D. Yoon, Best Presentation Award in PHM KOREA 2019, April, 2019



9) Yeongtak Oh, Kyumin Na, Myeongbaek Youn, and Byeng D. Yoon, Best Poster Award in PHM KOREA 2019, April, 2019



10) Hyunjae Kim and Byeng D. Yoon, Best Poster Award in PHM KOREA 2019, April, 2019



Patent

4 patents have been registered, including 2 international patents, and 14 patents have been applied.

International Patent

- 1) Byeng D. Youn, Byung Cheol Jeon, and Joon Ha Jung, Apparatus and Method for Diagnosing Rotor Shaft, Patent Registration, 10520354, December 31, 2019 (United States)
- 2) Byeng D. Youn, Deog Hyeon Kim, Yong Un Cho, Yongchae Lim, Hyunseok Oh, and Junmin Lee, Apparatus and Method for Failure Prognosis in Inverter, Patent Registration, 10495682, December 03, 2019 (United States)

Domestic Patent

- 1) Byeng D. Youn, Jungho Park, Yunhan Kim, and Kyumin Na, Fault Detection Apparatus and Method for Gears under Variable-Speed Condition Using Short-Time Fourier Transform, Patent Registration, 10-2077298, February 07, 2020
- 2) Byeng D. Youn, Jungho Park, Jong M. Ha, Yunhan Kim, and Kyumin Na, Vibration Characteristics Data Map Processing Apparatus for Diagnosing a Fault of Planetary Gear Box, Patent Registration, 10-2026065, September 23, 2019
- 3) Byeng D. Youn, Soo-Ho Jo, Hyeon Bae Kong, Joon Ha Jung, Jong M. Ha, Heonjun Yoon, and Yong Chang Shin, Hybrid Fatigue Crack Growth Prediction Method, Patent Application, 10-2020-006927, June 9, 2020
- 4) Byeng D. Youn, Myungyon Kim, Jin Uk Ko, Jinwook Lee, Yongjin Shin, and Hyeon Bae Kong, Fault Diagnosis Method of Rotating System Based on Transfer Learning, Patent Application, 10-2020-0052671, April 29, 2020
- 5) Byeng D. Youn, Jin Uk Ko, Myungyon Kim, Jinwook Lee, Yongjin Shin, and Hyeon Bae Kong, Fault Diagnosis Method for Rotor System Using Multi Task Learning, Patent Application, 10-2020-0050937, April 27, 2020
- 6) Byeng D. Youn, Soo-Ho Jo, Boseong Seo, Dongki Lee, and Hyunseok Oh, Fault Detection Method for Electronic Valve, Patent Application, 10-2020-0050114, April 24, 2020
- 7) Byeng D. Youn, Junmin Lee, Chan Hee Park, Giljun Ahn, and Myeongbaek Youn, Fault Diagnosis Method of Synchronous Motor, Patent Application, 10-2020-0026727, March 09, 2020
- 8) Byeng D. Youn, Yong Chang Shin, Heonjun Yoon, Soo-Ho Jo, Miso Kim, Choon-Su Park, and Wonjae Choi, Elastic Metamaterial Structure Having Octagonal Hole, Patent Application, 10-2020-0015201, February 07, 2020
- 9) Byeng D. Youn, Soo-Ho Jo, Heonjun Yoon, and Yong Chang Shin, Metamaterial-based Broadband Elastic Wave Collimator Harvester, Patent Application, 10-2020-0014426, February 06, 2020

- 10) Byeng D. Youn, Hyunjae Kim, and Wongon Kim, Method for Detecting Mechanical Anomaly of Tap-changer, Patent Application, 10-2019-0171488, December 20, 2019
- 11) Byeng D. Youn, Taewan Hwang, Dongkyu Lee, Jong Hyun Choi, Yong Chun Song, and Jungho Park, Method for Diagnosis Bearing Fault Based on Band Optimization and Apparatus for Performing the Same, Patent Application, 10-2019-0157132, November 29, 2019
- 12) Byeng D. Youn, Soo-Ho Jo, Heonjun Yoon, and Yong Chang Shin, Gradient Phononic Crystal-based Broadband Energy Harvester, Patent Application, 10-2019-0134990, October 29, 2019
- 13) Byeng D. Youn, Jungho Park, Hyunjae Kim, Taewan Hwang, Myungkyu Han, Jaekyung Shin, and Yong Chun Song, Condition Monitoring Data Generating Apparatus and Method Using Generative Adversarial Network, Patent Application, 10-2019-013961, October 23, 2019
- 14) Byeng D. Youn, Soo-Ho Jo, Heonjun Yoon, Yong Chang Shin, Miso Kim, and Wonjae Choi, Defect-based Broadband Energy Harvester, Patent Application, 10-2019-0132159, October 23, 2019
- 15) Byeng D. Youn, Sooho Kim, and Hyunhee Choi, Apparatus and Method for Preprocessing Data, Patent Application, 10-2019-0113261, September 16, 2019
- 16) Byeng D. Youn, Jungho Park, Yunhan Kim, and Kyumin Na, Apparatus and Method for Detecting Fault Using Time-Frequency Image, Patent Application, 10-2019-0063781, May 30, 2019

2 Project Updates

13 projects are in progress and 7 projects are successfully completed.

In Progress

- 1) Development of Deep Learning based Anomaly Detection Techniques for OHT (Overhead Hoist Transport) Driving Parts, Samsung Electronics (2020-05-21 ~ 2020-12-31)
- 2) Physics+AI Modeling and Evolution Methodology for Mechanical Systems, National Research Foundation of Korea (2020-03-01 ~ 2024-02-29)
- 3) Industrial Artificial Intelligence (AI) Human Resource Development (HRD), Ministry of Trade, Industry and Energy (2020-03-01 ~ 2024-02-28)
- 4) Industrial Artificial Intelligence for Intelligent Machines and Manufacturing Digitalization, Korea Institute for Advancement of Technology (2019-12-01 ~ 2022-11-30)
- 5) Structural Analysis for Pressurizing System Design of an All-Solid-State Battery, Hyundai Motor (2019-11-25 ~ 2020-11-24)

- 6) Operation of Industry-Academic Advisory Group for Improving Reliability and Process of Enterprise Parts, Hyundai Motor (2019-11-01 ~ 2020-10-31)
- 7) Development of Interconnected Modular Exo-Suit System Technology for Muscular Strength of Human's Waist, Shoulder, and Knee, Civil Military Technology Cooperation Center (2019-10-01 ~ 2021-09-30)
- 8) Automation Framework of Reliability-Based Battery Pack System Analysis Considering Cell Characteristics, Hyundai Motor (2019-04-15 ~ 2020-10-14)
- 9) Korea-Germany Intelligent Manufacturing Systems Laboratory, National Research Foundation of Korea (2018-08-01 ~ 2021-02-28)
- 10) Development of AI-based Diagnosis and Prognostics System for Power Plant, Korea Electric Power Corporation (2018-07-01 ~ 2021-10-31)
- 11) Development of Scale-Free Fault Diagnosis Techniques for Similar Mechanical Systems, Korean Institute of Machinery and Materials (2018-01-01 ~ 2020-12-31)
- 12) Development of Health State Diagnostics and Prognostics based on Integration of Artificial Intelligence and Expert Knowledge, Korea Electric Power Corporation (2017-08-01 ~ 2020-07-30)
- 13) Center for SoFT meta-Human (CSMH), Ministry of Science, ICT and Future Planning (2016-11-01 ~ 2022-12-31)

Completed

- 1) Analysis and Design of Elastic Metamaterials for Energy Focusing, National Research Council of Science & Technology (2017-05-22 ~ 2020-05-21)
- 2) Development of Fault Diagnosis/Prediction for Foaming Process, LG Electronics (2019-07-01 ~ 2019-12-31)
- 3) Development of 6-DOF Cooperative Robot Technology with Repetition Accuracy of 0.1mm and Payload of 15kg in Compliance with International Safety Certification Standard, Korea Evaluation Institute Of Industrial Technology (2017-04-01 ~ 2019-12-31)
- 4) Development of Machine Learning based Condition Monitoring Techniques for OHT(Overhead Hoist Transport) Driving Parts and Fault Detection Techniques for Stepper Motor, Samsung Electronics (2019-01-01 ~ 2019-12-31)
- 5) System Reliability Improvement and Validation for New Growth Power Industry Equipment, Korea Evaluation Institute Of Industrial Technology (2014-11-01 ~ 2019-10-31)
- 6) Research on Health Data and Fault Detection of Power Transformers, Samsung Electronics (2019-06-01 ~ 2019-11-30)
- 7) KF -X Engine Tendency Analysis and Review of Diagnostic System Needs, Korea Aerospace Industries (2019-01-31 ~ 2019-07-30)

3 Alumni News

SHRM alumni got ser appointments and awards from SHRM and other organizations recently, including professors, researchers and engineers.

Alumni



1) Dr. Soobum Lee was promoted to an Associate Professor with tenure at Department of Mechanical Engineering University of Maryland, Baltimore County in July 2019



2) Dr. Vikas Sharma has been appointed as an Assistant Professor at Department of Mechanical-Mechatronics Engineering, LNM Institute of Information Technology, Jaipur India in September 2019



3) Dr. Junpeng Zhao has been appointed as an Assistant Professor at School of Mechanical Engineering and Automation, Beihang University, Beijing, China in September 2019



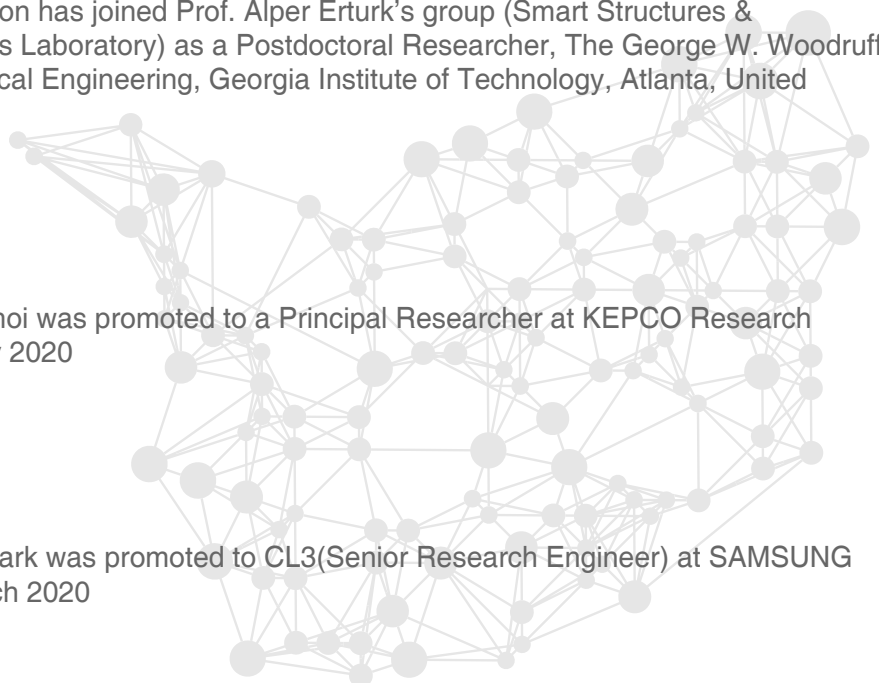
4) Dr. Heonjun Yoon has joined Prof. Alper Erturk's group (Smart Structures & Dynamical Systems Laboratory) as a Postdoctoral Researcher, The George W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology, Atlanta, United States.



5) Dr. Woosung Choi was promoted to a Principal Researcher at KEPCO Research Institute in January 2020



6) Mr. Kyungmin Park was promoted to CL3(Senior Research Engineer) at SAMSUNG Electronics in March 2020





7) Mr. Dongki Lee was promoted to a Senior Research at LG Electronics in March 2020



8) Dr. Jungho Park has worked for OnePredict Inc. from September 2019



9) Dr. Hyunjae Kim has worked for OnePredict Inc. from March 2020



10) Dr. Junmin Lee has worked for SAMSUNG Electronics from March 2020



11) Mr. Hao Yuan has worked for Huawei Devices co., Ltd from September 2019



12) Mr. Hyeon Bae Kong has worked for Riiid! Inc. from March 2020



13) Mr. Giljun Ahn entered School of Law at Seoul National University in March 2020



4 Students News

The graduates from the 1st semester of 2019 shared their stories about research in SHRM. 3 students have received on Ph.D. degree and 3 students have received on M.S. degree. Also, 1 postdoctoral researcher and 6 students have newly entered SHRM in the last one year.

Ph.D.



Jungho Park

In this dissertation, fault diagnosis methods are developed for planetary gears under variable-speed conditions. There are several challenges in developing the fault diagnosis methods for planetary gears under variable speeds: 1) fault sensitivity, 2) computation time, and 3) complex speed profile. To cope with these challenges, this dissertation is composed of three research thrusts. The first thrust proposes a fault diagnosis method with enhanced sensitivity. The method could improve fault sensitivity of the diagnostic method by minimizing effects from variable-speed conditions using the time-frequency analysis. Further, the faulty signals in the time-frequency analysis are enhanced in the developed method. Next, the second research thrust presents a time-efficient fault diagnosis method. In the method, time-efficient time-frequency analysis is used to reduce computation time. In the proposed method, the reduced fault sensitivity from the time-efficient time-frequency analysis is compensated by utilizing characteristics of signal and system. Finally, the third research thrust develops an image-based fault feature, which could extract fault-related characteristics independent of speed profiles. The proposed method could be applied to planetary gears under complex speed profiles. Each developed method could be used for planetary gears under variable-speed conditions for their use, i.e., fault sensitivity, time-efficiency, and complex speed profiles.



Hyunjae Kim

To cope with this insufficient fault data problem to train diagnostic model for rotating machinery, this thesis proposes three research thrusts:

- 1) filter-envelope blocks in convolution neural networks (CNNs) to incorporate the preprocessing steps for vibration signal; frequency filtering and envelope extraction for more optimal solution and reduced efforts in building diagnostic model,
- 2) cepstrum editing based data augmentation (CEDA) for diagnostic dataset consist of vibration signals from rotating machinery,
- 3) selective parameter freezing (SPF) for efficient parameter transfer in transfer learning.

The first research thrust proposes noble types of functional blocks for neural networks in order to learn robust feature to the vibration data. The second thrust presents a new data augmentation technique specialized for diagnostic data of vibration signals. By doing reverse transform to the edited cepstrum, the new samples is obtained and this results augmented dataset which leads to higher accuracy for the diagnostic model. The third research thrust suggests a new parameter repurposing method for parameter transfer, which is used for transfer learning. The proposed SPF selectively freezes transferred parameters from source network and re-train only unnecessary parameters for target domain to reduce overfitting and preserve useful source features when the target data is limited to train diagnostic model.

**Junmin Lee**

This paper proposes a fault diagnostics of IGBTs using system-level measurements. The proposed method can detect failure before it occurs and does not require any additional sensor. This thesis presents three research thrusts:

- 1) The first thrust proposes component-level fault diagnostics of IGBTs subjected to latent electrostatic discharge (ESD) damage that can lead to short-circuit failure. An aging test scheme is proposed. Also, the threshold voltage of IGBTs is proposed as a health feature that can quantify ESD-induced fault levels of IGBTs.
- 2) The second thrust develops models of motor drive systems at various fault levels with IGBTs subjected to latent ESD damage. The stator current signal from system-level models are simulated, and time-domain and frequency-domain analyses are conducted. The results show that more advanced health feature should be defined to detect the faults in motor drive systems using stator current signal.
- 3) The third thrust proposes fault diagnostics using system-level measurements for motor drive systems with faulty IGBTs. The proposed method does not require additional sensors as the method uses three-phase stator current signal that are already available for the control purpose. The results confirm that the proposed feature can detect the fault in IGBTs before the failure occurs.



M.S.**Hao Yuan**

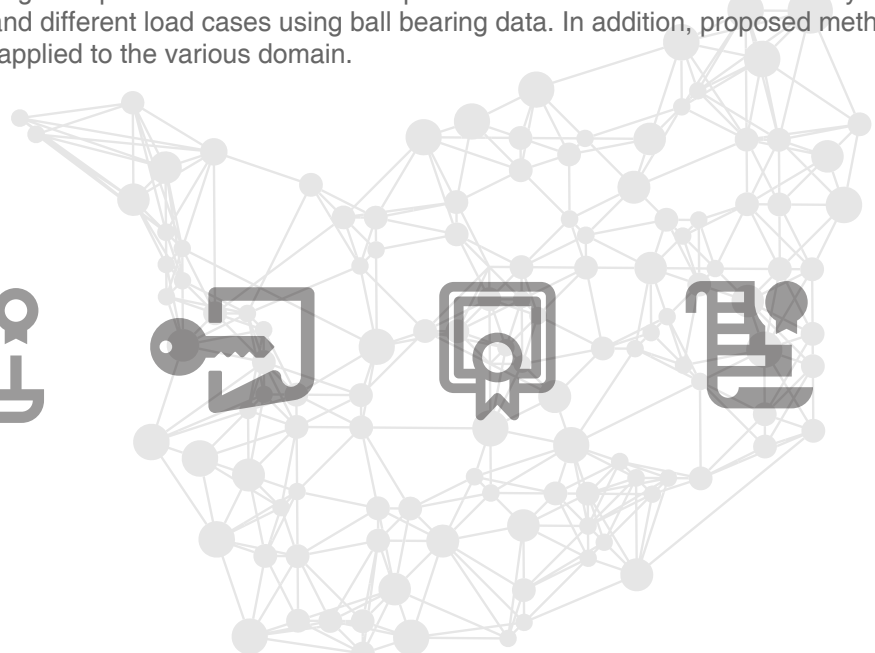
Unpredictable faults in the industrial robot could lead to interruptions in the whole manufacturing process. Since gearboxes are the main parts in industrial robots, fault detection of the gearboxes has been widely investigated, especially using vibration signal. However, the vibration signals from several gearboxes are mixed at each axes, which makes it difficult to locate a damaged gearbox. This paper develops a vibration signal separation technique under multiaxis interference. The developed method includes two steps, frequency domain independent component analysis (ICA-FD) and time domain independent component analysis (ICA-TD). ICA-FD is aimed at separating convolutive mixture of signals, and ICA-TD is aimed at eliminating the residual mixed components. The experiment results show that the proposed method could successfully separate the mixed signals, enhancing fault detection performance for the industrial robot gearboxes.

**Giljun Ahn**

This paper proposes a robust and simple method for detecting interturn short-circuit faults of surface-mounted permanent magnet synchronous motors (SPMSMs) based on the estimated disturbance. The total disturbance of motor with inter-turn short-circuit fault includes disturbance from several sources such as parameter variations, unmodeled dynamics and fault. The proposed method consists of three steps. First, the disturbance is estimated using disturbance observer (DBO). Second, the estimated disturbance is separated into faulty disturbance and healthy disturbance. The healthy disturbance consists of effects from parameter variations and unmodeled dynamics such as noise. Third, a new fault indicator is calculated which has a relationship with the fault severity and able to estimate the fault severity. The simulation results verify the effectiveness of the proposed method with steady state response and transient response. And these verify the robustness with parameter variations and noise. The proposed method can detect inter-turn short-circuit faults without additional sensors under uncertainties. This strength can facilitate on-line fault detection in industrial field applications.

**Hyeon Bae Kong**

This paper proposes an automated interpretable deep learning framework. The proposed method consists of two steps. First step is to optimize the neural network automatically by defining the neural architecture hyper-parameters with pre-trained model. By using pre-trained model and Bayesian optimization based neural architecture search, we can take advantages of the two methodologies. Second step is to make the existing deep learning model interpretable. The second step is divided into explaining the reason for the prediction of the individual data and estimating how confident prediction is. First step is a method to give analytical power in the time-frequency domain, which is mainly user for fault diagnosis of mechanical system. Second step is that predictive uncertainty is estimated through deep ensemble methods. Proposed method is validated under noisy environment and different load cases using ball bearing data. In addition, proposed method can be easily applied to the various domain.



New Postdoctoral Researcher and Students

2019 /



Dr. Haichao An
(Postdoctoral Researcher)



Mintae Kim
(Currently working
at Hewlett-Packard)



Donkyu Lee
(Currently working
at OnePredict)

2020 /



Dowan Kim



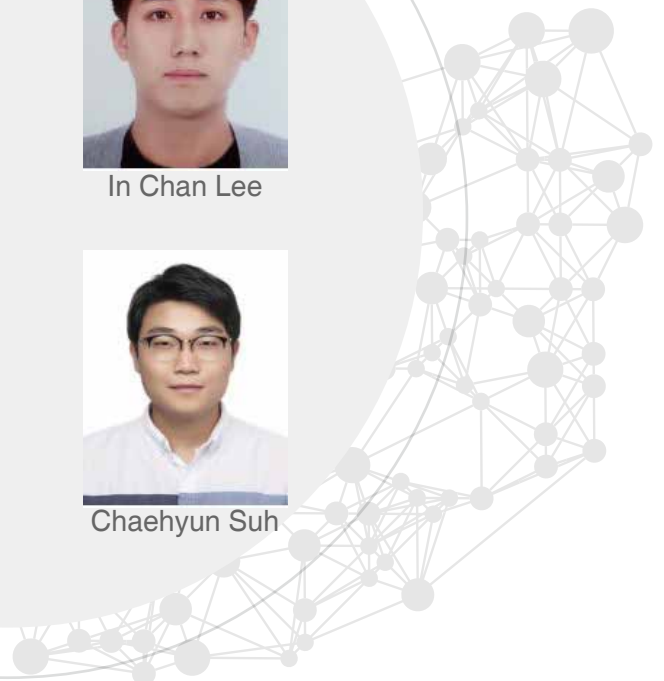
In Chan Lee



Hyeon Chan Lee



Chaehyun Suh



5 Press

Lots of articles about SHRM lab as well as OnePredict Inc. have been published

News Script



1) Oil Refining Industry & Chemical Industry Expands 'Startup Investment' in COVID19 Turbulent Times, UpDown News, 2020-06



2) OnePredict-NEARHLAB, MOU for Facility Safety Inspection and Diagnosis Solution, KLDaily, 2020-06



3) NIPA will support 15 future ICT unicorn companies and "help them enter the global market", Digital Daily, 2020-05



4) Ministry of Science and ICT, Selected 15 Companies for Future Unicorn Companies, including Mathpresso and OnePredict, Etoday, 2020-05



5) [Market Insight] Major Companies and VCs Invest Industrial AI which Korea Can Become the Best in the World, Hankyung, 2020-05



6) [Market Insight] Samsung Venture Investment & S-Oil, Invest in Industrial AI Startup Company, OnePredict.Inc., Hankyung, 2020-04



7) "Replace Bearing in 3 Months" Korean Western Power, Industrial AI-Based Remote Wind Farms, Sedaily, 2020-04



8) 'Predicting Industrial Facility Status' OnePredict.Inc., Successfully Funding, TheBell, 2020-04





9) Plant Shipbuilding Conference 2020, will be held in February 21, KLDaily, 2020-02



10) [Market Insight] OnePredict, Start-up Company of Smart Factory in Seoul National University, attracted investment worth 13 billion Won for Series B, Hankyung, 2020-01



11) Moonshot Style R&D Should Be Led by Disruptive Innovation, But Without Moving Forward....Slow Commercialization, Sedaily, 2020-01



12) More technology-based start-ups in universities can help boost the ecosystem of venture start-ups, Sedaily, 2019-12



13) [Market Insight] OnePredict, Professional Venture Company in Industrial AI Solutions, Accelerates Collaboration with Switzerland ABB, Hankyung, 2019-12



14) The Korean Reliability Society held a 20th Foundation Day Ceremony, Dailian, 2019-12



15) Built and Operated a Fault Prediction System for Artificial Intelligence-Based Wind Power Generators, Lawissue, 2019-11



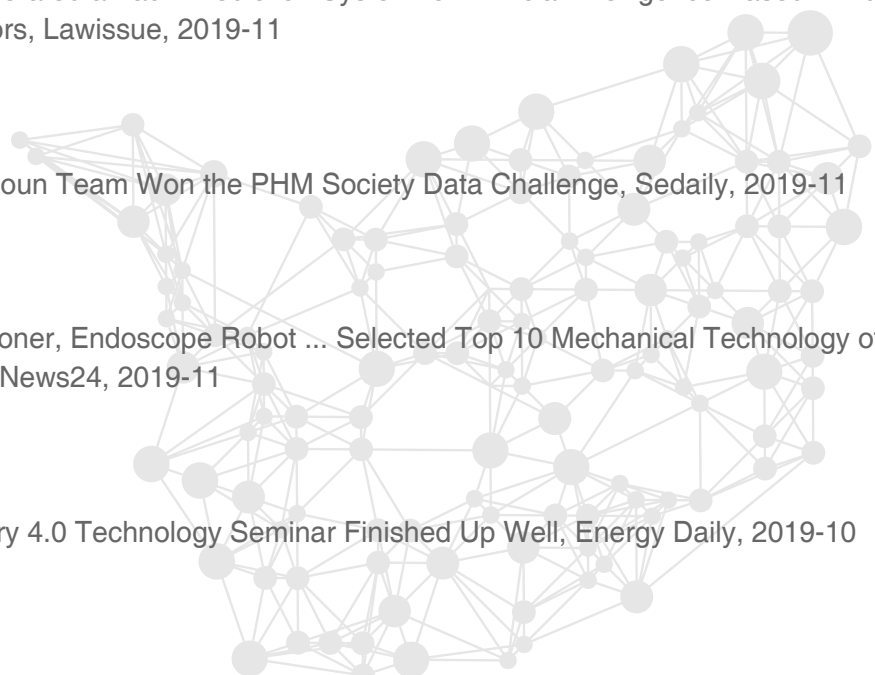
16) SNU Prof. Youn Team Won the PHM Society Data Challenge, Sedaily, 2019-11



17) AI Airconditioner, Endoscope Robot ... Selected Top 10 Mechanical Technology of the Year 2019, INews24, 2019-11



18) EWP Industry 4.0 Technology Seminar Finished Up Well, Energy Daily, 2019-10





19) Prof. Youn Byeng Dong of Seoul National University is nominated as the PHM Society Fellow, Digital Times, 2019-10



20) EWP Industry 4.0 Technology Seminar will be held, Maeil Business News Korea, 2019-10



21) [The Field of Engineering Education-Part 2] Laboratory for System Health and Risk management of Seoul National University, Ingenium, 2019-09



22) Confident of Technological Competitiveness ... Will become a leading unicorn company, Digital Times, 2019-09



23) Domain Knowledge-Based Data Preprocessing Technology for Deep Learning's Industry Application, Journal of Mechanical Science and Technology, 2019-08



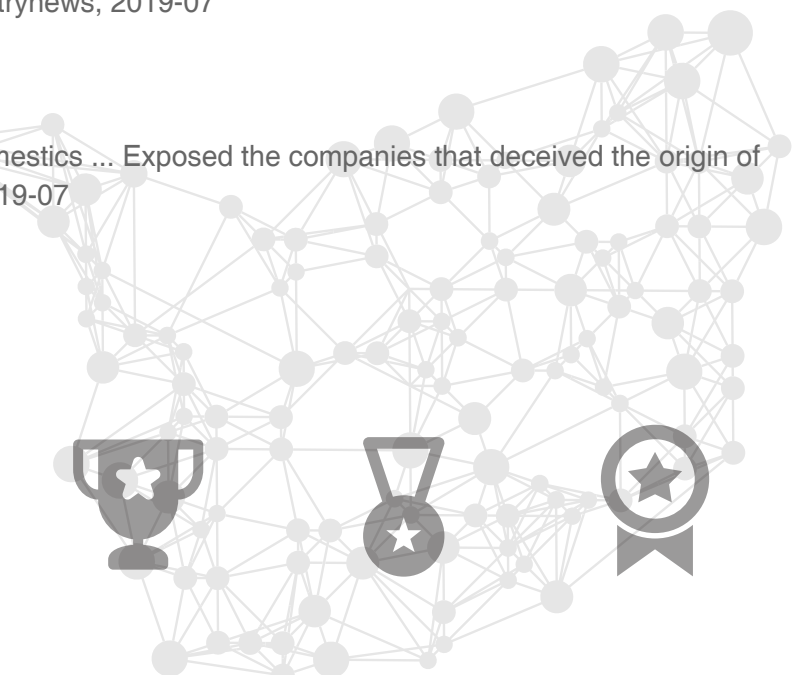
24) Luxembourg Deputy Prime Minister and Economic Mission meet Korean Start-up Companies, Platum, 2019-07



25) JYTEK Korea, Opened the Gate of 'Prediction Diagnosis of Industrial facilities in Smart Factory', Industrynews, 2019-07



26) Imported into Domestics ... Exposed the companies that deceived the origin of parts, TV Chosun, 2019-07



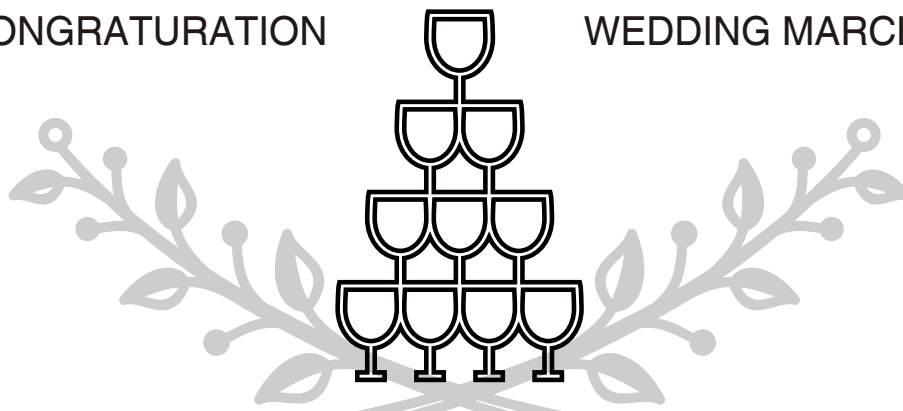
6 Other News and Events

News from SHRM Students, SHRM lab and Prof. Youn are presented with heartfelt greeting and thanks.

Family Event

CONGRATURATION

WEDDING MARCH!

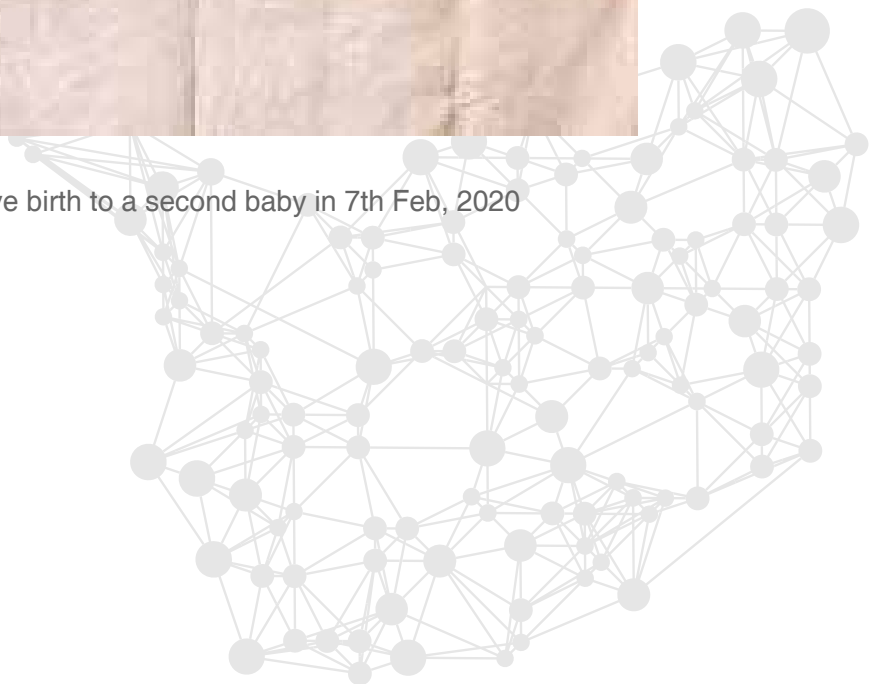


Dr. Jungho Park married on 10th May, 2020

CONGRATURATION!



Jisun Kim gave birth to a second baby in 7th Feb, 2020



Prof. Youn's Appointment

취임사 - 윤병동 신임회장

한국PHM학회 임원 및 회원 여러분께,

안녕하십니까? 한국PHM학회 제 2대 회장을 맡은 윤병동입니다. 바야흐로 대한민국이 4차 산업혁명 시대의 문턱에 서있는 이 시점에 회장직이라는 막중한 임무를 맡게 돼 영광으로 생각하며, 우리 학회의 발전에 조금이나마 기여할 수 있는 기회가 주어진 것에 진심으로 깊은 감사의 말씀을 드립니다.

우리 학회는 4차 산업혁명 시대를 주도하는 명실공히 대한민국 최고의 PHM 전문 학회로서, 2018년 창립된 이후 최후호 전 학회장님의 훌륭한 리더십 하에 'Industrial PHM'이라는 철학을 경립하였고, 학회의 100년 대계와 조직을 결성하였습니다. 이제 우리는 학회의 견고한 토대 위에서, 아래 'KSPHM Vision 2025'를 가슴에 품고 튼튼하고 실용적인 PHM건물을 설계하고 시공하고자 합니다



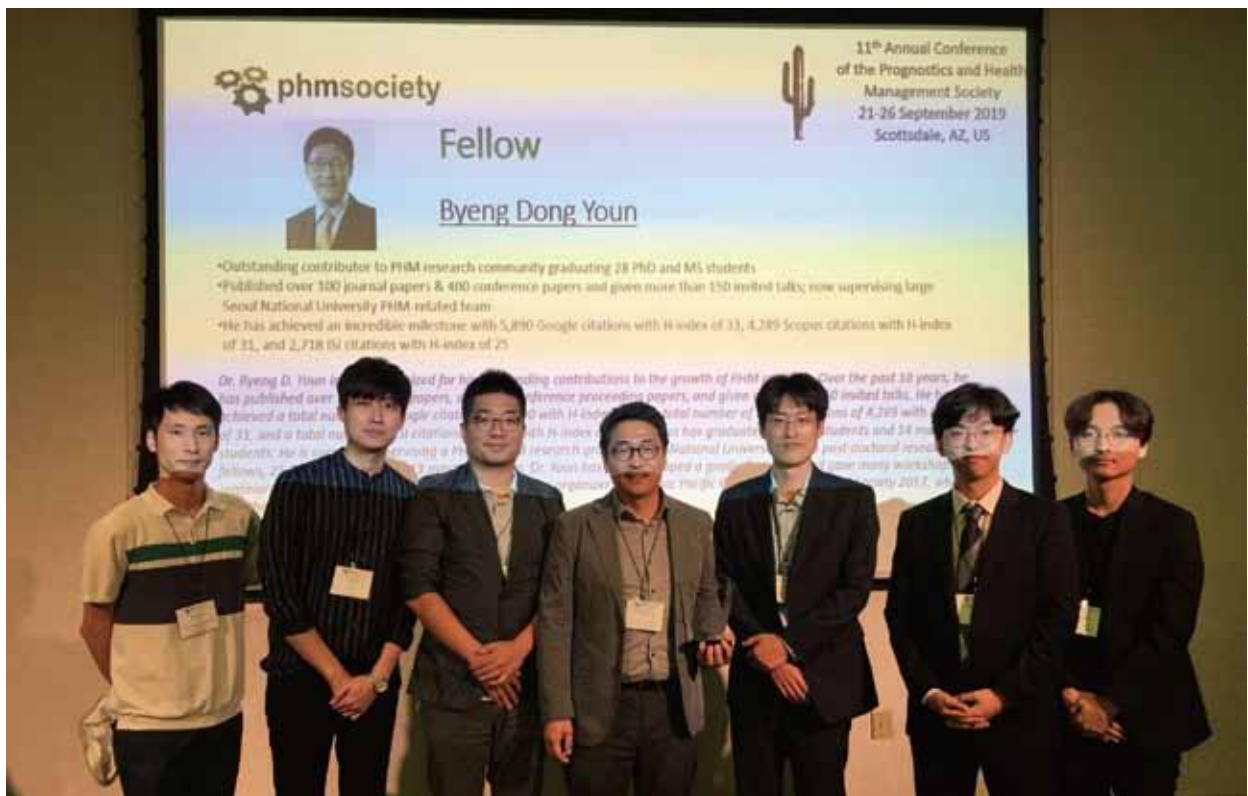
KSPHM Vision 2025: 회원 2,000명 확보, 회원사 50개 확보, 4차 산업혁명 리더 학회

한국PHM학회는 지속가능하고 혁신적인 미래 사회로의 변혁을 위한 역사적 책임을 다하고자 다음 세 가지 노력을 경주하고자 합니다. 첫째, 내실있고 지속가능한 학회사업모델 - 산업 지향적 교육 프로그램으로의 확대, 산업 포럼을 통한 성공사례 공유, 산업분과위원회 활성화, 국내 4차 산업혁명 생태계 구축 기여 및 정부 창구 역할, 국산 PHM 기술의 국제적 위상 확대 - 개발을 계획하고 있습니다. 둘째, 4차 산업혁명 리더학회 위상정립 - PHM Korea 2020(2020년 4월 8-10일), PHMAP21 유치, 20개 이상 회원사 및 800명 회원 확보, 대형 과제 유치 - 목표로 최선의 노력을 다하겠습니다. 셋째, 4차 산업혁명의 핵심 기술인 인공지능, 사물 인터넷, 빅데이터 등과 산업 도메인 지식을 결합하는 융합적 학문과 기술 개발의 장을 마련하고 더 나아가 견실한 산업 생태계를 만들어 가겠습니다.

한국PHM학회 회원 여러분, 우리 학회가 대한민국의 4차 산업혁명을 선도하는 시대적 사명을 감당할 수 있도록 아낌없는 조언과 관심을 가져주시기 바랍니다. 앞으로 한국PHM학회 2기(2019년 6월-2020년 12월) 임직원들은 역동적이고 건강한 학회로의 발전과 'KSPHM Vision 2025'를 향한 새로운 도전을 완수하기 위해 성실하게 봉사할 것을 약속 드립니다. 감사합니다.

한국PHM학회 회장 윤병동

June 2019, President of the Korean Society of Prognostics and Health Management (KSPHM)



September 2019, Fellow of PHM Society

SHRM Events

2019 Industrial AI Concert



서울대학교 시스템 건전성 및 리스크 관리 연구실(SHRM)에서 'Industrial AI Concert'를 개최합니다.

연구실 내에서 개발한 AI 기반 PHM 기술을 소개할 예정입니다. 여러분의 적극적인 참여를 기대합니다.

2019년 09월 20일(금) 9:00~17:00

장소 : 서울대학교 차세대자동차 연구센터 211호
(서울시 관악구 관악로1 서울대학교 차세대자동차 연구센터 211호)

등록대상 반도체, 자동차, 중공업 등 제조분야
일시 2019년 9월 20일(금) 까지 사전 등록
▶ <https://forms.gle/4Zs18gkYAJ9Rz9q9A>

참고사항 참가비 없음, 식사 및 주차권은 제공되지 않습니다.

관련문의 02-880-1664 / m22ndeng@gmail.com



09:00~09:30 접수 등록

개회사

09:30~09:40 인사 말씀
09:40~10:10 발표 / 윤병동 교수님

전력설비

10:10~10:30 주변압기 이상 감지 - 준감속 자동 인코더 신경망
10:30~10:50 가스 절연 개폐기 부분 방전 진단 - 합성곱 신경망
10:50~11:10 터빈 이상 조기 감지 - 자동 인코더 신경망
11:10~11:30 발전소 튜브 누설 감지 - 순환 합성곱 신경망
11:30~11:40 휴식 시간

회전체 - 저널 베어링

11:40~12:00 회전체 시스템 Label 정보 부재 해결
- 합성곱 신경망 기반 Domain Adaptation
12:00~12:20 회전체 시스템 고장 진단
- Bayesian Optimization based Neural Architecture Search
12:20~13:20 점심 시간

회전체 - 구름요소베어링, 모터, 기어박스

13:20~13:40 베어링 진단 전이학습 - 선택적 가중치 동결법
13:40~14:00 모터 고장 심각도 추정 - 특징 상층 합성곱 신경망
14:00~14:20 굴삭기 전처리 기반 고장 감지 - 전이 학습 합성곱 신경망
14:20~14:40 기어박스 고장 심각도 추정 - 적대적 생성 신경망
14:40~14:50 휴식 시간

로봇과 인간

14:50~15:10 산업용 로봇 고장 진단 - 도메인 적응 합성곱 신경망
15:10~15:30 심혈관계 질환 심각도 진단 - 적대적 학습 정규화

성공사례 - 자동차, 제조, 풍력, 발전, 송변전

15:30~15:50 Industrial AI 기술 상용 사례 - 거디원 솔루션(풍력, 발전, 송변전)
15:50~16:10 Industrial AI 기술 상용 사례 - 거디원 솔루션(자동차, 로봇)
16:10~16:40 Industrial AI 구현을 위한 JYTEK H / W 및 성공사례
16:40~16:50 맺음말



A Global Prognostics Solution
Leader for Industry 4.0

Industrial AI Concert 2019 SHRM



September 2019, Industrial AI Concert



May 2019, The 6th SHRM Homecoming Day

OnePredict News

- Investment - \$12 Million fund (Series B)
 - Corporate Venture Capital: Samsung Venture Investment, S-Oil
 - Venture Capital: Stonebridge Ventures, Atinum Investment, etc
- GuardiOne® Turbine released
- PoC- GuardiOne® Transformer (S-Oil)
- PoC- GuardiOne® Transformer (Incheon Total Energy Company)
- PoC- GuardiOne® Turbine (GS Power)
- Project – Vehicle Predictive Maintenance (Mando)
- South Korea's Ministry of Science and ICT selected OnePredict for its 'ICT Growth' program



OnePredict has successfully closed a \$12 million Series B round led by Stonebridge Ventures, Samsung Venture Investment, S-Oil and other leading venture capitals



OnePredict Photo

OnePredict selected as a member of the 'ICT Growth' program
 OnePredict joined 14 other startups in a ceremony celebrating startups that were selected by the Ministry of Science and ICT as potential South Korean unicorns

기업명	주요제품·서비스
매스프레소	■ 인공지능 기반 수학 학습 앱 '관타'
원프레딕트	■ 인공지능 산업설비 진단 솔루션
오픈엠티테크놀로지	■ 인공지능 기반 반도체 IP 설계
(주)아크릴	■ 인공지능 감성인식 플랫폼
(주)핏핏	■ 반려동물 소변검사 키트
클라우드웍스	■ 인공지능 학습데이터 수집·가공
프론티스	■ 지능형 가상·증강현실(VR/AR) 기술
(주)노을	■ 인공지능 기반 진단의료 플랫폼
(주)아이브스	■ 지능형 음원분석 CCTV
(주)메디퓨처스	■ 초음파 의료장비
(주)스마트레이더시스템	■ 4차원(4D) 이미지 레이더 센서
에이아이트릭스	■ 인공지능 기반 질병진단 지원 시스템
센트비	■ 해외 송금(핀테크)
솔라커넥트	■ 에너지 IT 플랫폼
(주)링크샵스	■ 도소매 거래 중개 시스템

Brating Startups of 'ICT Growth' Program





New Product Launch - GuardiOne® Turbine



GuardiOne® Turbine In-House Demonstration





November 2019, BIXPO



November 2019, Top 10 innovative technology of 2019 by the Korean Society of Mechanical Engineers

