PROCEEDINGS OF SPIE

Sensors and Smart Structures Technologies for Civil, Mechanical, and Aerospace Systems 2019

Jerome P. Lynch Haiying Huang Hoon Sohn Kon-Well Wang Editors

4–7 March 2019
Denver, Colorado, United States

Sponsored by SPIE

Cosponsored by OZ Optics, Ltd. (United States) Polytec, Inc. (United States)

Cooperating Organizations
Jet Propulsion Laboratory (United States)
Colorado Photonics Industry Association (United States)

Published by SPIE

Volume 10970

Part One of Two Parts

Proceedings of SPIE 0277-786X, V. 10970

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

Sensors and Smart Structures Technologies for Civil, Mechanical, and Aerospace Systems 2019, edited by Jerome P. Lynch, Haiying Huang, Hoon Sohn, Kon-Well Wang, Proc. of SPIE Vol. 10970, 1097001 © 2019 SPIE · CCC code: 0277-786X/19/\$18 · doi: 10.1117/12.2534358

The papers in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. Additional papers and presentation recordings may be available online in the SPIE Digital Library at SPIEDigital Library.org.

The papers reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from these proceedings:

Author(s), "Title of Paper," in Sensors and Smart Structures Technologies for Civil, Mechanical, and Aerospace Systems 2019, edited by Jerome P. Lynch, Haiying Huang, Hoon Sohn, Kon-Well Wang, Proceedings of SPIE Vol. 10970 (SPIE, Bellingham, WA, 2019) Seven-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510625952

ISBN: 9781510625969 (electronic)

Published by

SPIE

P.O. Box 10, Bellingham, Washington 98227-0010 USA
Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445

SPIE.org

Copyright © 2019, Society of Photo-Optical Instrumentation Engineers.

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$18.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at copyright.com. Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 0277-786X/19/\$18.00.

Printed in the United States of America by Curran Associates, Inc., under license from SPIE.

Publication of record for individual papers is online in the SPIE Digital Library.



Paper Numbering: Proceedings of SPIE follow an e-First publication model. A unique citation identifier (CID) number is assigned to each article at the time of publication. Utilization of CIDs allows articles to be fully citable as soon as they are published online, and connects the same identifier to all online and print versions of the publication. SPIE uses a seven-digit CID article numbering system structured as follows:

- The first five digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc. The CID Number appears on each page of the manuscript.

Contents

ix Authors

Conference Committee

Part One

	COMPUTER VISION AND AUGMENTED REALITY SOLUTIONS FOR SHM
10970 04	Non-contact modal parameters identification using a K-cluster algorithm [10970-3]
10970 05	An investigation on the relationship between distortions in the motion magnified videos, and the choice of filter bank $[10970-4]$
10970 07	Vision-based precision localization of UAVs for sensor payload placement and pickup for field monitoring applications [10970-7]
	ULTRASOUND/GUIDED WAVES
10970 08	Ultrasonic Lamb wave mode conversion to optical fiber guided mode with varying input conditions [10970-8]
10970 09	Waveguide sensing for structural health monitoring at elevated temperatures: simulating corrosion damage reconstruction [10970-9]
10970 OA	Industrial applications of electro-mechanical impedance technique in novel non-bonded configurations [10970-11]
10970 OB	Improved damage isolation using guided waves based on optimized sensor placement [10970-12]
10970 OD	Wave focusing in pipe-like structures via gradient-index metamaterial lens toward damage detection and localization $[10970\text{-}15]$
	MACHINE LEARNING AND DATA ANALYSIS
10970 OF	Addressing sensor drift in a proprioceptive optical foam system [10970-17]
10970 OH	DeepSHM: a deep learning approach for structural health monitoring based on guided Lamb wave technique [10970-19]

10970 01	Prediction of damage location in composite plates using artificial neural network modeling [10970-20]
	SMART MATERIALS INTEGRATION FOR SMART SYSTEMS
10970 OJ	SpaceSkin: development of aerospace-grade electronic textile for simultaneous protection and high velocity impact characterization [10970-21]
10970 OK	Performance of a water level sensor using magnetostrictive materials [10970-22]
10970 OL	A baseline free approach for multiple damage detection in beams [10970-23]
10970 OM	An analytical model for a shape memory alloy beam accounting for tension-compression stress asymmetry effect [10970-24]
	CASE STUDIES OF SHM IN CIVIL INFRASTRUCTURE SYSTEMS
10970 ON	Sensor data reconstruction and anomaly detection using bidirectional recurrent neural network [10970-25]
10970 00	Road vehicle classification using machine learning techniques [10970-26]
10970 OP	Reidentification of trucks in highway corridors using convolutional neural networks to link truck weights to bridge responses [10970-27]
10970 0Q	Instrumentation plan verification for damage detection of a vertical lift steel truss bridge [10970-28]
10970 OR	Passive extraction of Green's function of solids and application to high-speed rail inspection [10970-29]
10970 OS	Securing critical infrastructures with location based authentication blockchain [10970-30]
10970 OT	Large-scale monitoring of retaining structures: new approaches on the safety assessment of retaining structures using mobile mapping [10970-31]
	POWER HARVESTING FOR SELF-POWERED SENSORS
10970 OU	Modeling contact electrification in triboelectric impact oscillators as energy harvesters [10970-32]
10970 OW	Self-charging and self-monitoring smart civil infrastructure systems: current practice and future trends [10970-34]
10970 OX	Vibration-based energy harvesting circuit using feed-forward control [10970-35]

10970 OY	A multistable mechanism to detect thermal limits for structural health monitoring (SHM) [10970-36]
	ACTUATORS/ADAPTIVE STRUCTURES
10970 OZ	Auto-Gopher-II: an autonomous wireline rotary-hammer ultrasonic drill test results [10970-37]
10970 10	Development of synthetic jet actuator array for vortex-flow generation [10970-38]
10970 11	Development of a novel actuator for the application of a reconfigurable reflect array antenna [10970-39]
10970 12	Aerodynamics and structure measurement subsystem for a shape memory alloy actuated adaptive airfoil [10970-40]
	NANOCOMPOSITES AND FLEXIBLE SENSORS
10970 13	On the transient piezoresistive response of impacted nanofiber-modified epoxy [10970-41]
10970 14	Stochastic modeling of composite strain and fatigue sensing elements [10970-42]
10970 15	Autonomous structural composites for self-powered strain sensing-enabled damage detection [10970-43]
10970 16	Weatherability improvement of strain imaging sheet to use in real field for infrastructure inspection technology [10970-44]
10970 17	Evaluation of interfacial and micro-damage sensing of composites via Pencil Lead Drawing Paper Sensor (PLDPS) and Electrical Resistance (ER) mapping [10970-45]
10970 18	Development of a flexible piezocomposites surface acoustic wave sensor [10970-46]
10970 19	Flexible textile antenna sensor for bio-impedance sensing [10970-47]
10970 1A	Experimental identification of stress concentrations in piezoresistive nanocomposites via electrical impedance tomography [10970-48]
	PROXIMITY SENSORS FOR IOT SOLUTIONS
10970 1B	Detecting anomalies in longitudinal elevation of track geometry using train dynamic responses via a variational autoencoder [10970-49]
10970 1C	Incentivizing vehicular crowdsensing system for large scale smart city applications [10970-51]
10970 1D	Sleep monitoring using an infrared thermal array sensor [10970-53]

10970 1E	Monitoring induced floor vibrations: dance performance and bridge engineering [10970-55]
10970 1F	Enhancing the imaging performance of electrical capacitance tomography for monitoring osseointegrated prostheses [10970-57]
	HEALTH MONITORING OF LARGE-SCALE AND COMPLEX SYSTEMS
10970 1H	Online prognosis of fatigue crack at welded joints using nonlinear ultrasonic modulation [10970-50]
10970 11	Quantifying the benefit of SHM: can the Vol be negative? [10970-52]
Part Two	
10970 1J	Stress distribution monitoring of ground anchor using optical fiber-embedded strand [10970-54]
10970 1K	Use of bank of Kalman estimators for damage detection of buildings [10970-56]
10970 1L	Advanced sensor for in situ, NDE monitoring of nuclear reactors components integrity [10970-58]
10970 1M	Shape memory alloys for earthquake building protection [10970-60]
	MODELING OF SMART MATERIALS AND SENSOR PERFORMANCE
10970 1N	Theoretical model for laminated composite beam consisting of multiple superelastic shape memory alloy layers [10970-61]
10970 1Q	A microscale percolation model for nanocomposite complex impedance [10970-67]
	CONTROL AND ACTUATION OF DYNAMIC SYSTEMS
10970 1R	Sensor system benefits and costs in positive train control [10970-62]
10970 1S	Monitoring and control of structures considering diverse uncertainties [10970-64]
10970 1T	Bio-inspired iterative learning technique for more effective control of civil infrastructure [10970-66]
10970 1U	Design and analysis of a shock absorber with both tunable inertance and damping [10970-68]

OPTICAL FIBER SENSORS

10970 1V Structural health monitoring of solar trackers using distributed fiber optic senso	ors [10970-69]
Discerning localized thermal impulses using an embedded distributed optical network [10970-71]	fiber sensor
10970 1X Analysis of FBG reflection spectra under uniform and non-uniform transverse Id	oads [10970-73]
Test results of lateral load insensitive FBGs embedded in composites to suppre distortion [10970-75]	ss spectral
Simultaneous position and displacement sensing using two fibre Bragg grating [10970-77]	g sensors
SHM APPLICATIONS TO CONCRETE STRUCTURES	
10970 23 Experimental crack detection in concrete pavement using point strain sensors	s [10970-76]
	10.701
Numerical assessment of fatigue life of concrete frame using PZT sensors [1097]	(0-/8]
Numerical assessment of fatigue life of concrete frame using PZT sensors [1097] SENSOR DEVELOPMENT AND APPLICATIONS	·'0-78]
	·
SENSOR DEVELOPMENT AND APPLICATIONS 10970 26 A high sensitivity piezoelectric MEMS accelerometer based on aerosol depositivity piezoelectric MEMS accelerom	tion method
SENSOR DEVELOPMENT AND APPLICATIONS A high sensitivity piezoelectric MEMS accelerometer based on aerosol deposit [10970-89]	tion method 0-83]
SENSOR DEVELOPMENT AND APPLICATIONS A high sensitivity piezoelectric MEMS accelerometer based on aerosol deposit [10970-89] CMUT sensors based on circular membranes array for SHM applications [10970 28] Analysis of performances of MEMS infrared sensor based on piezoelectric ben	tion method D-83] ding resonators
SENSOR DEVELOPMENT AND APPLICATIONS A high sensitivity piezoelectric MEMS accelerometer based on aerosol deposition [10970-89] CMUT sensors based on circular membranes array for SHM applications [10970-10970-28] Analysis of performances of MEMS infrared sensor based on piezoelectric benta [10970-85] Application of piezoelectric MFC sensors and fiber Bragg grating sensors in street	tion method 0-83] ding resonators uctural health
SENSOR DEVELOPMENT AND APPLICATIONS A high sensitivity piezoelectric MEMS accelerometer based on aerosol deposit [10970-89] CMUT sensors based on circular membranes array for SHM applications [10970-87] Analysis of performances of MEMS infrared sensor based on piezoelectric bent [10970-85] Application of piezoelectric MFC sensors and fiber Bragg grating sensors in street monitoring of composite materials [10970-87]	tion method 0-83] ding resonators uctural health
SENSOR DEVELOPMENT AND APPLICATIONS A high sensitivity piezoelectric MEMS accelerometer based on aerosol deposition [10970-89] CMUT sensors based on circular membranes array for SHM applications [10970-10970-28] Analysis of performances of MEMS infrared sensor based on piezoelectric benta [10970-85] Application of piezoelectric MFC sensors and fiber Bragg grating sensors in strumonitoring of composite materials [10970-87] CO2 sensing characteristics of SAW sensor operated at high temperature [10970-87]	tion method 0-83] ding resonators uctural health

10970 2E	Large area distributed strain monitoring using patterned nanocomposite sensing meshes [10970-86]
109 <i>7</i> 0 2F	Feasibility of force detection in 3D printed flexible material using embedded sensors [10970-88]
10970 2G	Sensing sheets based on large area electronics for structural health monitoring of bridges [10970-90]
10970 2H	Piezoresistive type graphene nano platelet sensor for SHM application in structural components [10970-92]
	POSTER SESSION
10970 21	Robot tracking system research basing on optical sensors [10970-93]
10970 2J	Train speed estimation using low-cost GPS receivers [10970-94]
10970 2K	Design and analysis of flexible skin based on zero Poisson's ratio hybrid honeycomb [10970-95]
10970 2L	Active self-tuned mass damper for vibration control and continuous monitoring of civil structures [10970-96]
10970 2M	Design of a new magneto-rheological pressure seal for rotary shaft [10970-97]
10970 2N	A new magneto-rheological skin for controlling pressure of haptic devices [10970-98]
10970 20	Design of a new magneto-rheological damper featuring a hybrid type of piston for lower limb exoskeleton [10970-99]
10970 2P	Finite element model updating technique oriented to the bearing capacity improvement of bridges [10970-100]
10970 2Q	1 MHz high-sensitivity FBG sensor system to measure low energy impact in droplet experiment [10970-101]
10970 2R	Optimal design of electrodes for an electrical impedance tomography based flexible sensor [10970-102]
10970 2S	Fluid-structure interaction analysis for dynamic intraocular pressure monitoring in the human eye [10970-103]
10970 2T	Fiber-ring laser sensor system using a fiber Fabry-Pérot filter for ultrasound detection [10970-104]
10970 2U	An approach of identifying the parameters of IMFs based on PLF [10970-105]
10970 2W	Detecting underground metallic objects of different sizes using synthetic aperture radar

[10970-107]

10970 2X	Robot welding seam tracking system research basing on image identify [10970-108]
10970 2Y	Fabrication of biased-magnetorheological elastomers (B-MRE) based on magnetized ferromagnetic particles [10970-109]
10970 2Z	Damage detection and localization using random decrement technique on metallic plates [10970-110]
10970 30	A novel special optical waveguide structure with magneto-optic nonreciprocal phase shift under transversely applied magnetic field [10970-112]
10970 31	A new type of electromagnetic system for magnetorheological elastomer (MRE)-based base isolation system [10970-113]
10970 32	On-line response and damage estimation of a shear wall structure tested on a shake table using Bayesian filtering [10970-114]

Authors

Numbers in the index correspond to the last two digits of the seven-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first five digits reflect the volume number. Base 36 numbering is employed for the last two digits and indicates the order of articles within the volume. Numbers start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B...0Z, followed by 10-1Z, 20-2Z, etc.

Abdul Majid, Dayang L., 12 Abdullah, Ermira, 12 Abidin, Suzana, 12 Achaerandio, A., 1V Agüero, Marlon, 1E Al-Ansari, Adam M., 0Y Alavi, Amir H., 0W, 0Y Albright, Tyler B., 14 Alshandah, Mohanad, 23 Al-Tarawneh, Mu'ath, 00 Altintepe, Kadir, 1L Alzeyadi, Ahmed, 2W Ameduri, Salvatore, 1M Anton, Steven R., 2F Aono, Kenji, 0W Arifuku, Michiharu, 16 Atli-Veltin, Bilim, 1Y Aygun, Levent E., 2G

Azarbayejani, Mohammad, 29

Azid, Nuramira, 12 Bäcker, Dennis, 10 Badescu, Mircea, OZ Baek, Y. M., 17 Baghalian, Amin, Ol Bai, Xian-Xu, 1U

Balasubramanian, Krishnan, 09, 2H

Bao, Xiaoqi, OZ, 28 Bar-Cohen, Yoseph, OZ Barreiros, Jose A., OF Batt, Gregory, 0U Benedictus, Rinze, OH, 1Z Bergés, Mario, 1B Bhalla, Suresh, OA, OL, 24 Bhardwaj, Bhavana, 2J Bielak, Jacobo, 1B Bolognani, Denise, 11 Bourbon, G., 27 Bridgelall, Raj, 1R, 2J Bussini, Alberto, 2L Butaud, P., 27 Cai, Qinlin, 0X

Capriotti, Margherita, 0R Chakrabartty, Shantanu, OW Chang, Chia-Ming, 1K Chang, YuSheng, 2Z Chen, Zhangjie, 1D Chen, An, 2C Chen, Chao-Ting, 26

Chen, Xinlei, 1C

Chen, Yunguan, 2P Cheng, Junhua, 2T Cheng, Lun-Kai, 1Y, 2Q Cherston, Juliana, 0J Chia, Leonard, 2J

Choi, Seuna-Bok, 2M, 2N, 2O

Chou, Jau-Yu, 1K Concilio, Antonio, 1M Cui, Liang, 30

De Sa, Christopher M., OF

DeVries, L. K., 17

Do, Xuan Phu, 2M, 2N, 2O Dovgalenko, George, 1L Du, Xiaosong, 2C Erazo, Kalil, 32 Ewald, Vincentius, 0H Fang, Houfei, 11 Farhangdoust, Saman, Ol Fazzi, Luigi, 1X

Ferguson, Max, 0N Ferraioli, Massimiliano, 1M Flynn, Kyle, 0K

Fogg, Camille, 1T Frez, Clifford F., 28 Fudouzi, Hiroshi, 16 Gao, Jerry, 23 Garrett, James H., 1B Ghosh, Abhishek, 2A Ghosh, Sayantan, 09 Gibert, James, 0U Glisic, Branko, 2G Gong, Xuewen, 26

Groves, Roger M., 0H, 1X, 1Z

Gupta, Sumit, 1F, 2E Hackney, Drew, 08 Hagen, Ronald, 1Y, 2Q Hao, Zhiliang, 2R Haq, Moinul, 24 Hasni, Hassene, OW, OY

Hassan, H., 1A

Hayakawa, Michihiro, 1J Hernandez, J. A., 13 Hobeck, Jared D., 14

Hou, Rui, OP Hou, Yangqing, 11 Hu, Chao, 2C Hu, Jie, 2W Huang, Haiying, 19

Huang, Ying, 0O, 1R, 23

Hwang, Yongmoon, 31 Hyakutake, Tsuyoshi, 16 Ikei, Alec, 2D Imai, Michio, 1J Jackson, Shannon, OZ Jacobs, Rachel, OK Jansen, Rob, 1Y, 2Q Jedynska, Aleksandra, 1Y Jenkins, Brian, 1W Jeong, Seongwoon, ON, OP Jiang, Shuidong, 11 Jiang, Xuhai, 2T Jiao, Pengcheng, 0W, 0Y Jiménez, S., 1V Joe-Wong, Carlee, 1C Jones, Nicholas J., 0K Joseph, E., 27 Joyce, Peter, 1W Judez, A., 1V Jung, Gwang-Yong, 2S Jung, Hyung-Jo, 31 Kalenjuk, Slaven, OT Kaliske, M., 1S Kang, Byung-Hyuk, 2M, 2N, 2O Kim, Daewon, 18 Kim, Daniel, 0Z Kim, Gi-Woo, 2S Kim, J. H., 17 Kim, Yooil, 2S King, Bryan, 1R Kong, Adam, 1W Kottaram Amrithanath, Abhishek K., 30 Krishnaswamy, Sridhar, 30 Kudela, Pawel, OB Kumar, Vivek, 2G Kye, Seung-Kyung, 31 Laflamme, Simon, 2C Lajnef, Nizar, 0W, 0Y Lanza di Scalea, Francesco, OR Law, Kincho H., ON, OP Le Moal, P., 27 Le, Tran Huy Thang, 2N Lee, Choonghan, 2Y Lee, Hyeong Jae, 0Z Lee, Junghoon, 31 Leifsson, Leifur, 2C Li, Jingke, 2T Li, Rui, 2R Liang, Albert, OR Liao, Wei-Hsin, 26 Lienhart, Werner, OT

Lim, Hyung Jin, 1H

Liu, Yang, 2P Loayssa, A., 1V

Lu, Kai, 0Y

Lipowski, Mathias, 10 Liu, Jingxiao, 1B

Loh, Kenneth J., 1F, 2E

López Amo, M., 1V

Lu, Pan, 1R, 23, 2J Lynch, Jerome P., 07, 0P Ma, Tao, 2X Maharjan, Dilendra, 1E Mai Bui Quoc, Long, 2M, 2O Majidi, Carmel, 2D Malinowski, Pawel, OB Mao, Liming, 2T Mao, Zhu, 05 Mariñelarena, J., 1V Marte, Roman, 0T Martinez, Selene, 1E Matheson, Caleb, 29 Mehrabi, Armin, Ol Mehrkash, Milad, 0Q Mellerowicz, Boleslaw, 0Z Metz, Brandon, 0Z Miah, M. S., 1S Milazzo, Alberto, 1X Misla, Aaron, 15 Mohd. Rafie, Azmin S., 12 Molkenboer, Freek, 1Y, 2Q Mompó, J. J., 1V Mongare, Alfred, 15 Moreu, Fernando, 1E Mu, Wenjun, 2R Nagarajaiah, Satish, 32 Nakaue, Shinji, 1J Naqvi, Tabassum, 24 Nasrollahi, Amir, 04 Nazeer, Nakash, 1Z Nelson, Charles, 1W Netchaev, Anton, 2E Nitta, Hiroyuki, 16 Noble, Michael, 0\$ Noh, Hae Young, 1B, 1C Nuzzo, Domenico, 1M Oh, Jung-Sik, 2S Ohya, Takao, 16 Oikawa, Masashi, 1J Okubo, Kazumasa, 1J Okudan, G., 0D Ozevin, D., 0D Özütemiz, Kadri Buğra, 2D Paradiso, Joseph A., 0J Park, H. S., 17 Park, J. M., 17 Park, YoungHo, 15 Paulsen, Gale L., 0Z Peckens, Courtney A., 1T Peters, Kara, 08 Pi, Xidong, 1C Placet, V., 27 Ponder, Robert I., 2F Qiu, Tao, 2K Quigley, John, 11 Rais-Zadeh, Mina, 28 Rajabzadeh, Aydin, 1X Raju, Jayalakshmi, 0A

Ramachandran, Neha Vedavathi, 18 Ramasso, E., 27 Randhawa, Jashanjeet, OL, 24 Rebhan, Matthias J., 0T Resta, Ferruccio, 2L Ridgeway, Lucas, 29 Ripamonti, Francesco, 2L Rizzo, Piervincenzo, 04 Roberts, Heather R., 2F Rohde, Charles A., 2D Rojas-Nastrucci, Eduardo A., 18 Ryu, Donghyeon, 15 Safaei, Mohsen, 2F Sampath, Kaushik, 2D Santini-Bell, Erin, 0Q Sarrafi, Aral, 05 Scott, Valerie, 28 Sethy, Debadatta, 2H Shahsavari, Vahid, 0Q Shepherd, Robert F., OF Sherrit, Stewart, OZ, 28 Shi, Yuan, 2U Shin, P.S., 17 Shu, Xiaowu, 30 Skilskyj, James, 19 Sogabe, Naoki, 1J Sohn, Hoon, 1H Soman, Rohan, OB Sternini, Simone, OR Sturm, James C., 2G Sun, Hongwei, 21, 2X Talakokula, Visalakshi, 0A Tallman, T. N., 13, 1A, 1Q Tan, Zhicheng, 2P Tanaka, Yoshikazu, 16 Tansel, Ibrahim N., 01 Tao, Chuanyi, 2T Tao, Hongcheng, OU Tashakori, Shervin, Ol Tet, Ng W., 12 Thakur, Supriya, OA Tobe, Hayato, 1J Todoroki, Shin-ichi, 16 Toet, Peter, 1Y Tol, S., 0D Tolliver, Denver D., 1R, 23, 2J Torbol, Marco, 04 Tsuchiya, Koichi, 16 Ulibarri-Sanchez, Jordan, 15 Umer, R., 1N Urricelqui, J., 1V Valles, Zachary C., 0Z van der Togt, Oana, 1Y van Kempen, Floris, 1Y Van Meerbeek, Ilse M., OF van Megen, Davy, 2Q Vella, Gianmarco, 2E Verdin, B., 27

Verma, Naveen, 2G

Verzobio, Andrea, 11 Viet, N. V., 0M, 1N Vosteen, Amir, 1Y Wang, Xiaojie, 2R Wang, Ya, 1D Wang, Zhaohong, OS Wee, Junghyun, 08 Wei, Heming, 30 Wei, Yujie, 1B Wilson, Robert, OR Wissman, James, 2D Wu, Wen-Jong, 26 Wu, Maochuan, 2X Wyckoff, Elijah, 1E Xu, Susu, 1C Yan, Jin, 2C Yim, Woosoon, 2Y Yoo, JinHyeong, 0K Yu, Tzuyang, 2W Yuan, Fuh-Gwo, 2I Zacny, Kris, OZ Zagrai, Andrei, 15 Zaki, W., 0M, 1N Zekkos, Dimitrios, 07 Zhang, Chen, 2A Zhang, Dengwei, 30 Zhang, Haifeng, 2A Zhang, Jing, 2T Zhang, Pei, 1C Zhang, Tianjiao, 1F Zhao, Chang, 2K Zhao, Kang, 21 Zheng, Zhang, 2X Zheng, Zhangru, 21 Zhong, Wei-Min, 1U Zhou, Hao, 07 Zhou, Li, 2K, 2U Zhou, Lucas, 1E Zhu, An-Ding, 1U Zhu, Peter (Xuan), OR Zhu, Songye, OX Zonta, Daniele, 11 Zou, Feng, 21 Zurita, J., 1V

Conference Committee

Symposium Chairs

Tribikram Kundu, The University of Arizona (United States) **Gregory W. Reich**, Air Force Research Laboratory (United States)

Symposium Co-chairs

Zoubeida Ounaies, The Pennsylvania State University (United States) **Hoon Sohn**, KAIST (Korea, Republic of)

Conference Chair

Jerome P. Lynch, University of Michigan (United States)

Conference Co-chairs

Haiying Huang, The University of Texas at Arlington (United States) Hoon Sohn, KAIST (Korea, Republic of) Kon-Well Wang, University of Michigan (United States)

Conference Program Committee

Hiroshi Asanuma, Chiba University (Japan)

Chih Chen Chang, Hong Kong University of Science and Technology (Hong Kong, China)

Genda Chen, Missouri University of Science and Technology (United States)

Alison B. Flatau, University of Maryland, College Park (United States)

Branko Glisic, Princeton University (United States)

Faramarz Gordaninejad, University of Nevada, Reno (United States)

Benjamin L. Grisso, Naval Surface Warfare Center Carderock Div. (United States)

Ryan L. Harne, The Ohio State University (United States)

Jung-Wuk Hong, KAIST (Korea, Republic of)

Neil A. Hoult, Queen's University (Canada)

Ying Huang, North Dakota State University (United States)

Mohammad Reza Jahanshahi, Purdue University (United States)

Gi-Woo Kim, Inha University (Korea, Republic of)

Jeong-Tae Kim, Pukyong National University (Korea, Republic of)

Simon Laflamme, Iowa State University (United States)

Hui Li, Harbin Institute of Technology (China)

Jian Li, The University of Kansas (United States)

Suyi Li, Clemson University (United States)

Wei-Hsin Liao, The Chinese University of Hong Kong (Hong Kong, China)

Chin-Hsiung Loh, National Taiwan University (Taiwan)

Kenneth J. Loh, University of California, San Diego (United States)

Bryan R. Loyola, Sandia National Laboratories (United States)

Theodore E. Matikas, University of Ioannina (Greece)

Norbert G. Meyendorf, lowa State University of Science and Technology (United States)

Akira Mita, Keio University (Japan)

Yiging Ni, The Hong Kong Polytechnic University (Hong Kong, China)

Hae Young Noh, Carnegie Mellon University (United States)

Irving J. Oppenheim, Carnegie Mellon University (United States)

Wieslaw M. Ostachowicz, The Szewalski Institute of Fluid-Flow Machinery (Poland)

Kara J. Peters, North Carolina State University (United States)

Piervincenzo Rizzo, University of Pittsburgh (United States)

Donghyeon Ryu, New Mexico Institute of Mining and Technology (United States)

Liming W. Salvino, Office of Naval Research Global (United States)

Fabio Semperlotti, Purdue University (United States)

Wei Song, The University of Alabama (United States)

Wieslaw J. Staszewski, AGH University of Science and Technology (Poland)

Zhongqing Su, The Hong Kong Polytechnic University (Hong Kong, China)

R. Andrew Swartz, Michigan Technological University (United States)

Tyler N. Tallman, Purdue University (United States)

Jiong Tang, University of Connecticut (United States)

Marco Torbol, Ulsan National Institute of Science and Technology (Korea, Republic of)

Ming L. Wang, Northeastern University (United States)

Xingwei Wang, University of Massachusetts Lowell (United States)

Ya Wang, Texas A&M University (United States)

Yang Wang, Georgia Institute of Technology (United States)

Rosalind M. Wynne, Villanova University (United States)

Fuh-Gwo Yuan, North Carolina State University (United States)

Daniele Zonta, Università degli Studi di Trento (Italy)

Session Chairs

1 Keynote Session

Jerome P. Lynch, University of Michigan (United States) **Haiying Huang**, The University of Texas at Arlington (United States)

2 Computer Vision and Augmented Reality Solutions for SHM Marco Torbol, Ulsan National Institute of Science and Technology (Korea, Republic of)

Jerome P. Lynch, University of Michigan (United States)

3 Ultrasound/Guided Waves

Kara J. Peters, North Carolina State University (United States) **Serife Tol**, University of Michigan (United States)

4 Machine Learning and Data Analysis

Jerome P. Lynch, University of Michigan (United States)

5 Smart Materials Integration for Smart Systems Tyler N. Tallman, Purdue University (United States) Donghyeon Ryu, New Mexico Institute of Mining and Technology (United States)

6 Case Studies of SHM in Civil Infrastructure Systems Francesco Lanza di Scalea, University of California, San Diego (United States)

Denise Bolognani, University degli Studi di Trento (Italy) **Piervincenzo Rizzo**, University of Pittsburgh (United States)

- 7 Power Harvesting for Self-Powered Sensors Hae Young Noh, Carnegie Mellon University (United States) Zhongqing Su, The Hong Kong Polytechnic University (Hong Kong, China)
- 8 Actuators/Adaptive Structures Yoseph Bar-Cohen, Jet Propulsion Laboratory (United States) Ermira Abdullah, University Putra Malaysia (Malaysia)
- 9 Nanocomposites and Flexible Sensors
 Daewon Kim, Embry-Riddle Aeronautical University (United States)
 Haiying Huang, The University of Texas at Arlington (United States)
- Proximity Sensors for IoT Solutions
 Ya S. Wang, Texas A&M University (United States)
 Kenneth J. Loh, University of California, San Diego (United States)
- 10B Health Monitoring of Large-Scale and Complex Systems **Hyung Jim Lim**, KAIST (Korea, Republic of)
- 11A Modeling of Smart Materials and Sensor Performance
 Lingyu Yu, The University of South Carolina (United States)

- Control and Actuation of Dynamic Systems
 Courtney Peckens, Hope College (United States)
 Raj Bridgelall, North Dakota State University (United States)
- 12A Optical Fiber Sensors **R. Brian Jenkins**, U.S. Naval Academy (United States)
- SHM Applications to Concrete StructuresBranko Glisic, Princeton University (United States)Ying Huang, North Dakota State University (United States)
- Sensor Development and Applications
 Haifeng Zhang, University of North Texas (United States)
 Wei-Hsin Liao, The Chinese University of Hong Kong (Hong Kong, China)
- 13B Skin-based Distributed Sensing for SHM Applications Kenneth J. Loh, University of California, San Diego (United States) Austin Downey, The University of South Carolina (United States)