

PROCEEDINGS OF SPIE

Health Monitoring of Structural and Biological Systems 2012

Tribikram Kundu
Editor

12–15 March 2012
San Diego, California, United States

Sponsored by
SPIE

Cosponsored by
American Society of Mechanical Engineers (United States)

Cooperating Organizations
Intelligent Materials Forum (Japan)
Jet Propulsion Laboratory (United States)
National Science Foundation (United States)

Published by
SPIE

Volume 8348

Proceedings of SPIE, 0277-786X, v. 8348

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

The papers included 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. The papers published in these proceedings 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 this book:

Author(s), "Title of Paper," in *Health Monitoring of Structural and Biological Systems 2012*, edited by Tribikram Kundu, Proceedings of SPIE Vol. 8348 (SPIE, Bellingham, WA, 2012) Article CID Number.

ISSN 0277-786X

ISBN 9780819490056

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 © 2012, 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/12/\$18.00.

Printed in the United States of America.

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

The logo for SPIE Digital Library features the word "SPIE" in a bold, sans-serif font above the words "Digital Library" in a similar font. To the right of the text is a stylized graphic consisting of three vertical bars of increasing height, resembling a bar chart or a signal waveform.

SPIDigitalLibrary.org

Paper Numbering: Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent citation identifier (CID) number is assigned to each article at the time of the first 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, print, and electronic versions of the publication. SPIE uses a six-digit CID article numbering system in which:

- The first four 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. The complete citation is used on the first page, and an abbreviated version on subsequent pages. Numbers in the index correspond to the last two digits of the six-digit CID number.

Contents

Part One

- xiii *Conference Committee*
xvii *Introduction*

SESSION 1A GUIDED WAVES I: ANALYSIS AND SIGNAL PROCESSING

- 8348 02 **Comparison of analog and digital correlation methods suitable for ultrasonic structural health and load monitoring based on high temporal resolution** [8348-01]
G. Birkelbach, W. Grill, Univ. Leipzig (Germany)
- 8348 03 **Bimodal warped frequency transform (BWFT) for guided wave mode conversion characterization** [8348-02]
E. Baravelli, Georgia Institute of Technology (United States); L. De Marchi, N. Speciale, Univ. degli Studi di Bologna (Italy); M. Ruzzene, Georgia Institute of Technology (United States)
- 8348 04 **Acoustic emission (AE) source localization using extended Kalman filter (EKF)** [8348-03]
E. Dehghan Niri, S. Salamone, P. Singla, Univ. at Buffalo/SUNY (United States)
- 8348 05 **Fingerprinting the Lamb wave signals by using S-transformation** [8348-04]
I. N. Tansel, Florida International Univ. (United States); A. Yapici, Mustafa Kemal Univ. (Turkey); S. Korla, Florida International Univ. (United States); M. Demetgul, Marmara Univ. (Turkey)

SESSION 1B WIND TURBINE AND CONCRETE MONITORING

- 8348 06 **Damage detection in carbon composite material typical of wind turbine blades using auto-associative neural networks** [8348-05]
N. Dervilis, R. Barthorpe, I. Antoniadou, The Univ. of Sheffield (United Kingdom); W. J. Staszewski, AGH Univ. of Science and Technology (Poland); K. Worden, The Univ. of Sheffield (United Kingdom)
- 8348 0A **Improvement method for impedance-based nondestructive evaluation on concrete structures using a piezoceramic material** [8348-08]
S. Na, H. K. Lee, KAIST (Korea, Republic of)

SESSION 2A GUIDED WAVES II: MONITORING PIPES AND OTHER STRUCTURES

- 8348 0B **A permanently installed guided wave system for pipe monitoring** [8348-09]
A. Galvagni, P. Cawley, Imperial College London (United Kingdom)
- 8348 0C **Imaging of pipeline defects based on extraction of mode-converted guided waves** [8348-10]
H. Lee, H. Sohn, KAIST (Korea, Republic of); H. W. Park, Dong-A Univ. (Korea, Republic of)

- 8348 0D **Bayesian probabilistic modeling for damage assessment in a bolted frame** [8348-11]
C. Haynes, M. Todd, Univ. of California, San Diego (United States)
- 8348 0E **Guided waves for monitoring heat treatment duration and material hardness** [8348-12]
N. Korde, T. Kundu, The Univ. of Arizona (United States)

SESSION 2B SHM USING ELECTRICAL PROPERTIES OF MATERIALS

- 8348 0G **Enhanced health monitoring of fibrous composites with aligned carbon nanotube networks and electrical impedance tomography** [8348-14]
T. Tallman, Univ. of Michigan (United States); F. Semperlotti, Univ. of Notre Dame (United States); K. W. Wang, Univ. of Michigan (United States)
- 8348 0H **Inductively coupled transducer system for damage detection in composites** [8348-15]
C. H. Zhong, A. J. Croxford, P. D. Wilcox, Univ. of Bristol (United Kingdom)
- 8348 0I **Admittance-based damage detection method using a higher-order circuit** [8348-16]
W. Zhou, G. R. Penamalli, L. Zuo, Stony Brook Univ./SUNY (United States)

SESSION 3A GUIDED WAVES III: MODELING AND ANALYSIS

- 8348 0L **Numerical simulation of wave propagation in composite plates** [8348-19]
K. S. Nadella, C. E. S. Cesnik, Univ. of Michigan (United States)
- 8348 0M **Elastic waves simulation using CUDA technology and multiple GPU workstations** [8348-20]
P. Packo, T. Uhl, W. J. Staszewski, AGH Univ. of Science and Technology (Poland)
- 8348 0N **Assessment of the excitelet algorithm for in-situ mechanical characterization of orthotropic structures** [8348-21]
P.-C. Ostiguy, N. Quaegebeur, P. Masson, Univ. de Sherbrooke (Canada)
- 8348 0O **Guided-wave-based structural health monitoring of built-up composite structures using spectral finite element method** [8348-22]
A. Vezhapparambu, G. Srinivasan, Indian Institute of Science (India)
- 8348 0P **Imaging non-classical elastic nonlinearities using reciprocal time reversal and phase symmetry analysis** [8348-23]
F. Ciampa, M. Meo, Univ. of Bath (United Kingdom)
- 8348 0Q **Evaluation of cylindrical Hertzian contact using guided waves** [8348-24]
N. Kim, S. Yang, Korea Univ. of Technology and Education (Korea, Republic of)
- 8348 0R **Characterization of mode selective actuator and sensor systems for Lamb wave excitation** [8348-25]
D. Schmidt, C. Heinze, W. Hillger, A. Szewieczek, M. Sinapius, P. Wierach, Deutsches Zentrum für Luft- und Raumfahrt e.V. (Germany)

SESSION 3B MEDICAL AND BIOLOGICAL APPLICATIONS I

- 8348 OS **Pulse thermography for quantitative nondestructive evaluation of sound, de-mineralized and re-mineralized enamel** [8348-26]
M. Ando, Indiana Univ. (United States); N. Sharp, D. Adams, Purdue Univ. (United States)
- 8348 OT **Design and fabrication of mechanical-resonance-based optical scanner using push-pull actuator** [8348-27]
K. Gu, C. L. Tsui, J. Ho, Univ. of Washington (United States); W.-C. Wang, Univ. of Washington (United States) and National Cheng Kung Univ. (Taiwan)
- 8348 OU **Noninvasive ultrasonic monitoring of the mechanical properties of selected muscles and connected tendons** [8348-28]
M. Zakir Hossain, W. Grill, Univ. Leipzig (Germany)
- 8348 OV **Fabrication and characterization of polymer gel for MRI phantom with embedded lesion particles** [8348-29]
E. In, H. E. Naguib, M. Haider, Univ. of Toronto (Canada)
- 8348 OW **Compact Fourier transform spectrometer without moving parts** [8348-30]
C.-Y. Huang, B. Estroff, Univ. of Washington (United States); W.-C. Wang, Univ. of Washington (United States) and National Cheng Kung Univ. (Taiwan)

SESSION 4A GUIDED WAVES IV: AEROSPACE APPLICATIONS

- 8348 OX **Integral ultrasonic structural health and load monitoring on a fiber reinforced polymer-based composite helicopter tail boom** [8348-31]
G. Birkelbach, Univ. Leipzig (Germany); I. J. Aldave, I. López, Fundación Centro de Tecnologías Aeronáuticas (Spain); W. Grill, Univ. Leipzig (Germany)
- 8348 OY **Integral structural health and load monitoring of a helicopter tail boom manufactured from aluminum sheet metal with support from frames and stringers by guided ultrasonic waves** [8348-32]
G. Birkelbach, W. Grill, Univ. Leipzig (Germany); S. Kuznetsov, V. Pavelko, Riga Technical Univ. (Latvia)

SESSION 4B SENSOR NETWORK, SIGNAL PROCESSING, AND FEATURE EXTRACTION

- 8348 10 **Cointegration as a data normalization tool for structural health monitoring applications** [8348-34]
D. Y. Harvey, M. D. Todd, Univ. of California, San Diego (United States)
- 8348 11 **Uncertainty propagation of transmissibility-based structural health monitoring features** [8348-35]
Z. Mao, M. Todd, Univ. of California, San Diego (United States)

- 8348 12 **An experimental study on disbond detection in a thermal insulation system using guided waves under a load-temperature environment** [8348-36]
Y. Wang, Dalian Univ. of Technology (China) and Commercial Aircraft Corp. of China, Ltd. (China); S. Ma, Z. Wu, K. Liu, Dalian Univ. of Technology (China); X. Qing, Commercial Aircraft Corp. of China, Ltd. (China)

SESSION 5A GUIDED WAVES V: MODELING AND SIMULATION

- 8348 13 **Multiple scattering of Lamb waves by multiple corrosion pits in a plate** [8348-37]
B. W. Strom, S. Krishnaswamy, J. D. Achenbach, Northwestern Univ. (United States)
- 8348 15 **High-frequency guided ultrasonic waves for the detection of hidden defects in multi-layer aerospace structures** [8348-39]
B. Masserey, C. Raemy, HES-SO Fribourg (Switzerland); P. Fromme, Univ. College London (United Kingdom)
- 8348 16 **Determination of the transport properties of ultrasonic waves traveling in piezoelectric crystals by imaging with Coulomb coupling** [8348-40]
A. Habib, Univ. Siegen (Germany); A. Shelke, The Univ. of Arizona (United States); U. Pietsch, Univ. Siegen (Germany); T. Kundu, The Univ. of Arizona (United States); W. Grill, Univ. Leipzig (Germany)

SESSION 5B NOVEL DEVICES AND APPLICATIONS

- 8348 17 **Inkjet fabrication of spiral frequency-steerable acoustic transducers (FSATs)** [8348-41]
E. Baravelli, M. Senesi, D. Gottfried, Georgia Institute of Technology (United States); L. De Marchi, Univ. degli Studi di Bologna (Italy); M. Ruzzene, Georgia Institute of Technology (United States)
- 8348 18 **Nondestructive evaluation of acoustic properties of fuel cell proton-exchange membranes by vector contrast acoustic microscopy** [8348-42]
A. E. Kamanyi, W. Grill, Univ. Leipzig (Germany)
- 8348 19 **PEDOT pillar fabrication using DOD inkjet system** [8348-43]
W. Cui, C.-L. Chang, Univ. of Washington (United States); W.-C. Wang, Univ. of Washington (United States) and National Cheng Kung Univ. (Taiwan)
- 8348 1A **Laser ultrasonic imaging of a rotating blade** [8348-44]
B. Park, T. T. Chung, C. M. Yeum, H. Sohn, KAIST (Korea, Republic of)

SESSION 6A MODELING AND SIMULATION RELATED TO SHM

- 8348 1C **Application of multi-objective optimization to structural damage estimation via model updating** [8348-46]
F. Shabbir, P. Omenzetter, The Univ. of Auckland (New Zealand)
- 8348 1D **Robust method to identify damages in beams based on frequency shift analysis** [8348-47]
G.-R. Gillich, Z.-I. Praisach, Univ. Eftimie Murgu Resita (Romania)

- 8348 1E **On optimized placement of multidirectional piezoelectric layers for multimodal energy scavenging: a theoretical study** [8348-48]
S. Banerjee, Univ. of South Carolina (United States)
- 8348 1F **Simulation of ultrasonic NCF composites testing using 3D finite element model** [8348-49]
Z. Liu, Beijing Univ. of Technology (China); N. Saffari, P. Fromme, Univ. College London (United Kingdom)

SESSION 6B SHM FOR SPACE AND AEROSPACE INDUSTRIES

- 8348 1G **Vibration-based monitoring to detect mass changes in satellites** [8348-50]
A. Maji, B. Vernon, The Univ. of New Mexico (United States)
- 8348 1H **In-situ measurement of viscoelastic effects in composite tape springs** [8348-51]
A. J. Makuch, Penn State Univ. (United States) and Air Force Research Lab. (United States);
W. D. Reynolds, Air Force Research Lab. (United States)
- 8348 1I **Structural assurance testing for post-shipping satellite inspection** [8348-52]
W. D. Reynolds, D. Doyle, B. Arritt, Air Force Research Lab. (United States)
- 8348 1J **Design, development, and assembly of sub-orbital space flight structural health monitoring experiment** [8348-53]
W. R. Reiser, B. Runnels, C. White, A. Light-Marquez, A. Zagrai, D. Siler, S. Marinsek, A. Murray, New Mexico Institute of Mining and Technology (United States); S. Taylor, G. Park, C. Farrar, Los Alamos National Lab. (United States); R. Sansom, New Mexico Institute of Mining and Technology (United States)

Part Two

SESSION 7A GUIDED WAVES VI: MONITORING COMPOSITES

- 8348 1L **Real-time prediction of impact-induced damage for composite structures based on failure analysis and efficient database methods** [8348-55]
S. Roy, I. Mueller, V. Janapati, Stanford Univ. (United States); S. Das, Acellent Technologies Inc. (United States); F.-K. Chang, Stanford Univ. (United States)
- 8348 1M **SHM system using rectangular versus circular piezoceramic for the inspection within the bond of a composite bonded joint** [8348-56]
N. Quaegebeur, P. Micheau, P. Masson, Univ. de Sherbrooke (Canada); M. Castaings, I2M, CNRS, Univ. de Bordeaux I (France)
- 8348 1O **Ultrasonic guided wave characterization and damage detection in foam-core sandwich panel using PWAS and LDV** [8348-59]
N. Chakraborty, D. Roy Mahapatra, G. Srinivasan, Indian Institute of Science (India)
- 8348 1P **Lamb-wave-based feature extraction of damage in a stiffened composite panel under varying temperature** [8348-60]
A. J. Vizzini II, A. Chattopadhyay, Arizona State Univ. (United States)

- 8348 1Q **Guided-wave-based damage detection in a composite T-joint using 3D scanning laser Doppler vibrometer** [8348-61]
G. Kolappan Geetha, D. Roy Mahapatra, G. Srinivasan, Indian Institute of Science (India)

SESSION 7B MEDICAL AND BIOLOGICAL APPLICATIONS II

- 8348 1R **Large beam deflection using cascaded prism array** [8348-62]
W.-C. Wang, Univ. of Washington (United States) and National Cheng Kung Univ. (Taiwan);
C.-L. Tsui, Univ. of Washington (United States)
- 8348 1S **Prediction of ultrasonic guided waves excitability to support the noninvasive assessment of human long bones** [8348-63]
G. Castellazzi, A. Marzani, Univ. degli Studi di Bologna (Italy); I. Bartoli, Drexel Univ. (United States)
- 8348 1T **Mechanical property quantification of endothelial cells using scanning acoustic microscopy** [8348-64]
A. Shelke, Johann Wolfgang Goethe-Univ. Frankfurt am Main (Germany); S. Brand, Fraunhofer-Institut für Werkstoffmechanik (Germany); T. Kundu, The Univ. of Arizona (United States); J. Bereiter-Hahn, C. Blase, Johann Wolfgang Goethe-Univ. Frankfurt am Main (Germany)
- 8348 1U **A platform-based foot pressure/shear sensor** [8348-65]
C.-T. Chang, Southern Taiwan Univ. (Taiwan); C. S. Liu, National Defense Univ. (Taiwan);
W. Soetanto, Univ. of Washington (United States); W.-C. Wang, Univ. of Washington (United States) and National Cheng Kung Univ. (Taiwan)

SESSION 8 METAMATERIALS I

- 8348 1V **Particle focusing in a microfluidic channel with acoustic metamaterial** [8348-66]
X. B. Cai, The Univ. of Western Ontario (Canada) and Beijing Institute of Technology (China);
Q. Q. Guo, The Univ. of Western Ontario (Canada); G. K. Hu, Beijing Institute of Technology (China); J. Yang, The Univ. of Western Ontario (Canada)
- 8348 1W **Dissipation-triggered phenomena in periodic acoustic metamaterials** [8348-67]
M. J. Frazier, M. I. Hussein, Univ. of Colorado at Boulder (United States)
- 8348 1X **Numerical effective formulation for guided wave propagation in a metamaterial plate with anisotropic mass density** [8348-68]
R. Zhu, Univ. of Arkansas at Little Rock (United States); M. Reynolds, Univ. of Arkansas at Fort Smith (United States); G. L. Huang, Univ. of Arkansas at Little Rock (United States)

SESSION 9 CIVIL INFRASTRUCTURE I: BUILDING MONITORING

- 8348 1Y **Estimation of changes in modal parameters of a seismically isolated building during the 2011 earthquake off the Pacific coast of Tohoku** [8348-69]
T. Saito, Shimizu Corp. (Japan)

- 8348 1Z **Synergistic combination of systems for structural health monitoring and earthquake early warning for structural health prognosis and diagnosis** [8348-70]
S. Wu, J. L. Beck, California Institute of Technology (United States)
- 8348 20 **Output only earthquake damage detection of moment resist frame using wavelet analysis and fractal dimension** [8348-71]
D. Tao, H. Li, Y. Huang, Y. Bao, Harbin Institute of Technology (China)

SESSION 10 METAMATERIALS II

- 8348 23 **Analytical formulation of a discrete chiral elastic metamaterial model** [8348-74]
X. N. Liu, Beijing Institute of Technology (China); G. L. Huang, Univ. of Arkansas at Little Rock (United States); G. K. Hu, Beijing Institute of Technology (China)
- 8348 25 **Multi-displacement microstructure modeling of two-dimensional elastic metamaterials** [8348-76]
A. P. Liu, Beijing Institute of Technology (China) and Univ. of Arkansas at Little Rock (United States); G. K. Hu, Beijing Institute of Technology (China); Z. H. Jin, Univ. of Maine (United States); G. L. Huang, Univ. of Arkansas at Little Rock (United States)
- 8348 26 **Thin-plate metamaterials: physics and applications** [8348-77]
P. Li, X. Zhou, S. Yao, Beijing Institute of Technology (China); G. Huang, Univ. of Arkansas at Little Rock (United States); G. Hu, Beijing Institute of Technology (China)

SESSION 11 CIVIL INFRASTRUCTURE II: BRIDGE MONITORING

- 8348 27 **Modeling and analysis of a biomorph piezoelectric energy harvester for railway bridge monitoring** [8348-79]
J. Li, S. Jang, J. Tang, Univ. of Connecticut (United States)
- 8348 28 **An impedance-based approach for detection and quantification of damage in cracked plates and loose bolts in bridge structures** [8348-80]
M. Rabiei, J. Sheldon, C. Palmer, Impact Technologies (United States)
- 8348 29 **Flexibility-based damage detection for in-service highway bridge** [8348-81]
S. Dahal, S. Jang, P. Mensah-Bonsu, Univ. of Connecticut (United States)
- 8348 2A **Evaluation of bridge span by recovered stiffness data obtained with moving vehicle loadings** [8348-82]
C.-C. Cheng, C.-P. Yu, Y.-T. Ke, K.-T. Hsu, Chaoyang Univ. of Technology (Taiwan)
- 8348 2C **Recovery of lost data for wireless sensor network used in structural health monitoring** [8348-84]
Y. Bao, H. Li, Harbin Institute of Technology (China); X. Sun, Harbin Engineering Univ. (China); J. Ou, Harbin Institute of Technology (China) and Dalian Univ. of Technology (China)

- 8348 2D **Visualization of active crack on bridge in use by mechanoluminescent sensor** [8348-85]
N. Terasaki, National Institute of Advanced Industrial Science and Technology (Japan);
C.-N. Xu, National Institute of Advanced Industrial Science and Technology (Japan) and
Japan Science and Technology Agency (Japan); C. Li, L. Zhang, C. Li, D. Ono, M. Tsubai,
Y. Adachi, Y. Imai, N. Ueno, National Institute of Advanced Industrial Science and
Technology (Japan); T. Shinokawa, Taisei Kiso Sekkei Co., Ltd. (Japan)

SESSION 12 NONLINEAR TECHNIQUES FOR SHM

- 8348 2E **Predictive simulation of nonlinear ultrasonics** [8348-86]
Y. Shen, V. Giurgiutiu, Univ. of South Carolina (United States)
- 8348 2F **Identification of nonlinearities for damage inspection of thin-walled structures** [8348-87]
P. F. Pai, Univ. of Missouri-Columbia (United States); M. J. Sundaresan, North Carolina A&T
State Univ. (United States); B. A. Nguyen, Univ. of Missouri-Columbia (United States)
- 8348 2G **Sensor location analysis for nonlinear-acoustics-based damage detection in composite structures** [8348-88]
A. Klepka, W. J. Staszewski, AGH Univ. of Science and Technology (Poland); F. Aymerich,
Univ. degli Studi di Cagliari (Italy); T. Uhl, AGH Univ. of Science and Technology (Poland)

SESSION 13 OPTICAL DEVICES AND TECHNIQUES FOR SHM

- 8348 2H **Dynamic fiber Bragg grating strain sensor using a wavelength-locked tunable fiber ring laser** [8348-89]
Y. Zhu, S. Krishnaswamy, Northwestern Univ. (United States)
- 8348 2I **Dynamic characteristics of a wind turbine blade using 3D digital image correlation** [8348-90]
J. Baqersad, J. Carr, T. Lundstrom, C. Niezrecki, P. Avitabile, Univ. of Massachusetts Lowell
(United States); M. Slattery, Southwest Windpower (United States)
- 8348 2J **In-situ acousto-ultrasonic monitoring of crack propagation in Al2024 alloy** [8348-91]
P. A. Vanniamparambil, I. Bartoli, K. Hazeli, J. Cuadra, E. Schwartz, R. Saralaya, A. Kotsos,
Drexel Univ. (United States)
- 8348 2K **2D metal profile detector using a polymeric fiber optic sensor** [8348-92]
W.-S. Hua, National Taiwan Univ. (Taiwan); J. R. Hooks, N. A. Erwin, Univ. of Washington
(United States); W.-J. Wu, National Taiwan Univ. (Taiwan); W.-C. Wang, Univ. of Washington
(United States) and National Cheng Kung Univ. (Taiwan)

SESSION 14 UNCERTAINTIES IN SHM AND PIPE MONITORING

- 8348 2N **Detection and monitoring of axial cracks on cylindrical structures using torsional wave generated by piezoelectric macro-fiber composite** [8348-95]
L. Cui, S. I. Lim, M. Shi, Y. Liu, C. K. Soh, Nanyang Technological Univ. (Singapore)

POSTER SESSION

- 8348 2P **Damage detection in underwater composite structures using ultrasonic guided waves** [8348-57]
F. Yan, O. M. Malinowski, X. Zhao, FBS Inc. (United States); J. L. Rose, FBS Inc. (United States) and The Pennsylvania State Univ. (United States)
- 8348 2R **Multi-objective optimization strategies for damage detection using cloud model theory** [8348-99]
J. Zhou, A. Mita, R. Li, Keio Univ. (Japan)
- 8348 2S **Fatigue damage monitoring for basalt fiber reinforced polymer composites using acoustic emission technique** [8348-100]
W. Wang, H. Li, Z. Qu, Harbin Institute of Technology (China)
- 8348 2T **Breathing crack detection using Lamb wave and DORT method** [8348-101]
W. Qu, L. Xiao, Wuhan Univ. (China)
- 8348 2U **Nonlinear structural damage detection using support vector machines** [8348-102]
L. Xiao, W. Qu, Wuhan Univ. (China)
- 8348 31 **Harvesting energy from the dynamic deformation of an aircraft wing under gust loading** [8348-110]
M. Pozzi, S. Guo, M. Zhu, Cranfield Univ. (United Kingdom)
- 8348 32 **Experimental characterisation of macro fibre composites and monolithic piezoelectric transducers for strain energy harvesting** [8348-111]
M. Pozzi, A. Canziani, I. Durazo-Cardenas, M. Zhu, Cranfield Univ. (United Kingdom)
- 8348 34 **Moving forces and their bounds identification method for cable-stayed bridges with uncertain parameters and noisy measurements** [8348-113]
F. Zhang, H. Li, Harbin Institute of Technology (China)
- 8348 37 **Stochastic optimization using automatic relevance determination prior model for Bayesian compressive sensing** [8348-117]
Y. Huang, Harbin Institute of Technology (China) and California Institute of Technology (United States); J. L. Beck, S. Wu, California Institute of Technology (United States); H. Li, Harbin Institute of Technology (China)
- 8348 39 **Displacement amplifier design for an extensometer in high temperature deformation monitoring** [8348-119]
X. Y. Hu, J. H. Jia, S. T. Tu, East China Univ. of Science and Technology (China)
- 8348 3A **Numerical studies on a novel damage localization feature of cantilever beams using standard deviation and curvature method** [8348-120]
Y. An, J. Ou, Dalian Univ. of Technology (China)

Author Index

Conference Committee

Symposium Chairs

Norbert G. Meyendorf, Fraunhofer-Institut für Zerstörungsfreie Prüfverfahren (United States) and University of Dayton (United States)
Norman M. Wereley, University of Maryland, College Park (United States)

Symposium Cochairs

Victor Giurgiutiu, University of South Carolina (United States)
Christopher S. Lynch, University of California, Los Angeles (United States)

Conference Chair

Tribikram Kundu, The University of Arizona (United States)

Conference Cochair

Wolfgang Grill, Universität Leipzig (Germany)

Program Committee

Douglas E. Adams, Purdue University (United States)
Sourav Banerjee, Acellent Technologies, Inc. (United States)
Yoseph Bar-Cohen, Jet Propulsion Laboratory (United States)
Fu-Kuo Chang, Stanford University (United States)
Anthony J. Croxford, University of Bristol (United Kingdom)
Paul Fromme, University College London (United Kingdom)
Victor Giurgiutiu, University of South Carolina (United States)
Daniel Guyomar, Institut National des Sciences Appliquées de Lyon (France)
Shivan Haran, Arkansas State University (United States)
Guoliang Huang, University of Arkansas at Little Rock (United States)
Sridhar Krishnaswamy, Northwestern University (United States)
Francesco Lanza di Scalea, University of California, San Diego (United States)
Jerome P. Lynch, University of Michigan (United States)
Jennifer E. Michaels, Georgia Institute of Technology (United States)
Won-Bae Na, Pukyong National University (Korea, Republic of)
Christopher Niezrecki, University of Massachusetts Lowell (United States)
Paul D. Panetta, Applied Research Associates, Inc. (United States)

P. Frank Pai, University of Missouri-Columbia (United States)
Dominique Placko, École Normale Supérieure de Cachan (France)
Henrique L. Reis, University of Illinois at Urbana-Champaign
(United States)
Piervincenzo Rizzo, University of Pittsburgh (United States)
Hoon Sohn, KAIST (Korea, Republic of)
Nobuo Takeda, The University of Tokyo (Japan)
Michael D. Todd, University of California, San Diego (United States)
Wei-Chih Wang, University of Washington (United States)
Andrei N. Zagrai, New Mexico Institute of Mining and Technology
(United States)
George Zentai, Varian Medical Systems, Inc. (United States)

Session Chairs

- 1a Guided Waves I: Analysis and Signal Processing
Tribikram Kundu, The University of Arizona (United States)
Wolfgang Grill, Universität Leipzig (Germany)
- 1b Wind Turbine and Concrete Monitoring
Christopher Niezrecki, University of Massachusetts Lowell
(United States)
Wieslaw J. Staszewski, The University of Sheffield (United Kingdom)
- 2a Guided Waves II: Monitoring Pipes and Other Structures
Hoon Sohn, KAIST (Korea, Republic of)
Francesco Lanza di Scalea, University of California, San Diego
(United States)
- 2b SHM Using Electrical Properties of Materials
Jerome P. Lynch, University of Michigan (United States)
George Zentai, Varian Medical Systems, Inc. (United States)
- 3a Guided Waves III: Modeling and Analysis
Alessandro Marzani, Università degli Studi di Bologna (Italy)
Hoon Sohn, KAIST (Korea, Republic of)
- 3b Medical and Biological Applications I
Wei-Chih Wang, University of Washington (United States)
- 4a Guided Waves IV: Aerospace Applications
Paul Fromme, University College London (United Kingdom)
- 4b Sensor Network, Signal Processing, and Feature Extraction
Piervincenzo Rizzo, University of Pittsburgh (United States)
Lingyu Yu, University of South Carolina (United States)

- 5a Guided Waves V: Modeling and Simulation
Sridhar Krishnaswamy, Northwestern University (United States)
Sourav Banerjee, University of South Carolina (United States)
- 5b Novel Devices and Applications
Wolfgang Grill, Universität Leipzig (Germany)
Lingyu Yu, University of South Carolina (United States)
- 6a Modeling and Simulation Related to SHM
Sourav Banerjee, University of South Carolina (United States)
Daniel Guyomar, Institut National des Sciences Appliquées de Lyon (France)
- 6b SHM for Space and Aerospace Industries
Andrei N. Zagrai, New Mexico Institute of Mining and Technology (United States)
P. Frank Pai, University of Missouri-Columbia (United States)
- 7a Guided Waves VI: Monitoring Composites
Paul Fromme, University College London (United Kingdom)
Nobuo Takeda, The University of Tokyo (Japan)
- 7b Medical and Biological Applications II
George Zentai, Varian Medical Systems, Inc. (United States)
Wei-Chih Wang, University of Washington (United States)
- 8 Metamaterials I
Guoliang Huang, University of Arkansas at Little Rock (United States)
Amr M. Baz, University of Maryland, College Park (United States)
- 9 Civil Infrastructure I: Building Monitoring
Shivan Haran, Arkansas State University (United States)
Robert Phillips, University of California, San Diego (United States)
- 10 Metamaterials II
Guoliang Huang, University of Arkansas at Little Rock (United States)
Amr M. Baz, University of Maryland, College Park (United States)
- 11 Civil Infrastructure II: Bridge Monitoring
Piervincenzo Rizzo, University of Pittsburgh (United States)
Scott A. Ouellette, University of California, San Diego (United States)
- 12 Nonlinear Techniques for SHM
Victor Giurgiutiu, University of South Carolina (United States)
Daniel Guyomar, Institut National des Sciences Appliquées de Lyon (France)

- 13 Optical Devices and Techniques for SHM
 Daniel Guyomar, Institut National des Sciences Appliquées de Lyon
 (France)
 Xinlin P. Qing, Commercial Aircraft Corporation of China, Ltd. (China)
- 14 Uncertainties in SHM and Pipe Monitoring
 Xinlin P. Qing, Commercial Aircraft Corporation of China, Ltd. (China)
 Jinkyu Yang, California Institute of Technology (United States)

Introduction

In 2001 the SPIE conference (Conf. 4335) on Health Monitoring of Structural and Biological Systems brought engineers, materials scientists, medical doctors, and biologists together to exchange their ideas on this important issue. After having a positive experience at that conference, yearly conferences were organized on the same topic and the next one has been planned for the year 2013. This volume contains papers presented at the 2012 conference. Papers presented in the earlier conferences can be found in Proceedings of SPIE volumes 4335 (2001), 4702 (2002), 5047 (2003), 5394 (2004), 5768 (2005), 6177 (2006), 6532 (2007), 6935 (2008), 7295 (2009), 7650 (2010) and 7984 (2011).

The emphasis of this conference is to recognize that sensing by nondestructive evaluation, sensor array design, signal acquisition and transmission, signal processing, energy harvesting, etc. are integral parts of health monitoring for both structural and biological systems. I believe that biological and physical science communities are learning from each other by coming to this conference and exchanging ideas. Some of the recent advances in the science and technology of health monitoring techniques that go beyond the traditional nondestructive testing for internal flaw detection are presented in these proceedings. New diagnosis, prognosis, and rehabilitation techniques applied to engineering structures made of metal, concrete, and composites, as well as biological systems are presented. The papers published here cover a wide range of technologies. It is hoped that this conference will stimulate further interactions between physical and life science community resulting in newer development of more innovative techniques for health monitoring applications.

I am thankful to the conference cochair, program committee members, authors, session chairs, and the SPIE staff for putting together this excellent conference.

Tribikram Kundu

