## PROCEEDINGS OF SPIE

# Industrial and Commercial Applications of Smart Structures Technologies 2013

Kevin M. Farinholt Steven F. Griffin Editors

10–14 March 2013 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 8690

Proceedings of SPIE 0277-786X, V. 8690

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

Industrial and Commercial Applications of Smart Structures Technologies 2013, edited by Kevin M. Farinholt, Steven F. Griffin, Proc. of SPIE Vol. 8690, 86900P © 2013 SPIE · CCC code: 0277-786X/13/\$18 · doi: 10.1117/12.2030019

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 Industrial and Commercial Applications of Smart Structures Technologies 2013, edited by Kevin M. Farinholt, Steven F. Griffin, Proceedings of SPIE Vol. 8690 (SPIE, Bellingham, WA, 2013) Article CID Number.

ISSN: 0277-786X ISBN: 9780819494733

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 © 2013, 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/13/\$18.00.

Printed in the United States of America.

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



**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**

v Conference Committee

SESSION 1	SMART STRUCTURES TECHNOLOGIES FOR CONTROL
8690 01	Active structures to reduce torsional vibrations [8690-1] M. Matthias, D. Schlote, H. Atzrodt, Fraunhofer Institute Structural Durability and System Reliability LBF (Germany)
8690 02	Nonlinear dynamic model for magnetically-tunable Galfenol vibration absorbers [8690-2] J. J. Scheidler, M. J. Dapino, The Ohio State Univ. (United States)
8690 03	Active damping for wind-tunnel aeroelastic models of large civil structures [8690-3] G. Cazzulani, T. Balduzzi, F. Ripamonti, D. Rocchi, Politecnico di Milano (Italy)
8690 04	Miniature multifunctional high-performance three-axis positioning and scanning platform [8690-4] D. Avirovik, Virginia Polytechnic Institute and State Univ. (United States); D. Dave, The Univ. of Texas at Arlington (United States); S. Priya, Virginia Polytechnic Institute and State Univ. (United States)
SESSION 2	ENABLING TECHNOLOGIES FOR EMBEDDED SENSING
8690 05	High-strain measurement using fiber Bragg grating sensors [8690-5] V. Sotoudeh, R. J. Black, J. Costa, F. Faridian, B. Moslehi, L. Oblea, Intelligent Fiber Optic Systems Corp. (United States); W. P. Roush, G. Wang, Q. H. Zuo, The Univ. of Alabama in Huntsville (United States)
8690 06	Three-axis distributed fiber optic strain measurement in 3D woven composite structures [8690-6] M. Castellucci, S. Klute, E. M. Lally, M. E. Froggatt, Luna Innovations Inc. (United States); D. Lowry, NASA Johnson Space Ctr. (United States)
8690 07	Powering embedded electronics for wind turbine monitoring using multi-source energy harvesting techniques [8690-7] S. R. Anton, S. G. Taylor, E. Y. Raby, Los Alamos National Lab. (United States); K. M. Farinholt, Commonwealth Ctr. for Advanced Manufacturing (United States)
8690 08	Multi-source energy harvesting for wireless SHM systems [8690-8] M. Choi, Chonbuk National Univ. (Korea, Republic of); K. M. Farinholt, Commonwealth Ctr. for Advanced Manufacturing (United States); S. Anton, Los Alamos National Lab. (United States); JR. Lee, Chonbuk National Univ. (Korea, Republic of); G. Park, Chonnam National Univ. (Korea, Republic of)

8690 09	<b>Piezoelectric wind turbine</b> [8690-9] R. A. Kishore, S. Priya, Virginia Polytechnic Institute and State Univ. (United States)
SESSION 3	AEROSPACE APPLICATIONS
8690 0A	Adaptive magnetorheological seat suspension for shock mitigation [8690-10] H. J. Singh, N. M. Wereley, Univ. of Maryland, College Park (United States)
8690 OB	Online acoustic emission monitoring of combustion turbines for compressor stator vane crack detection [8690-11] S. Momeni, J. P. Koduru, M. Gonzalez, B. Zarate, V. Godinez, MISTRAS Group, Inc. (United States)
8690 OC	Actuation needs for an adaptive trailing edge device aimed at reducing fuel consumption on a regional aircraft [8690-12] G. Diodati, A. Concilio, Italian Aerospace Research Ctr. (Italy)
8690 OD	An adaptive control system for wing TE shape control [8690-13]  I. Dimino, A. Concilio, Italian Aerospace Research Ctr. (Italy); M. Schueller, A. Gratias, Fraunhofer ENAS (Germany)
8690 OE	Estimated performance of an adaptive trailing-edge device aimed at reducing fuel consumption on a medium-size aircraft [8690-14] G. Diodati, A. Concilio, Italian Aerospace Research Ctr. (Italy); S. Ricci, A. De Gaspari, Politecnico di Milano (Italy); F. Huvelin, A. Dumont, JL. Godard, ONERA, The French Aerospace Lab. (France)
8690 OF	Design and development of an active Gurney flap for rotorcraft [8690-15] J. Freire Gómez, J. D. Booker, P. H. Mellor, Univ. of Bristol (United Kingdom)
SESSION 4	AUTOMOTIVE APPLICATIONS
8690 OH	SMA actuated vertical deploy air dam: part 2 operation and test performance of prototype unit [8690-17]  A. L. Browne, N. L. Johnson, General Motors Corp. (United States); J. Brown, Dynalloy, Inc. (United States)
8690 OI	Nonlinear dynamic modeling for smart material electro-hydraulic actuator development [8690-18] J. P. Larson, M. J. Dapino, The Ohio State Univ. (United States)
	Author Index

#### Conference Committee

#### Symposium Chairs

Norbert G. Meyendorf, Fraunhofer-Institut für Zerstörungsfreie Prüfverfahren (Germany) and University of Dayton (United States) Norman 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

**Kevin M. Farinholt**, Commonwealth Center for Advanced Manufacturing (United States)

#### Conference Cochair

Steven F. Griffin, Boeing LTS Inc. (United States)

#### Conference Program Committee

Eric H. Anderson, CSA Engineering, Inc. (United States)
Emil V. Ardelean, Schafer Corppration (United States)
Brandon J. Arritt, Air Force Research Laboratory (United States)
Christian Boller, Fraunhofer-Institut für Zerstörungsfreie Prüfverfahren (Germany)

Diann E. Brei, University of Michigan (United States)
Alan L. Browne, General Motors Corporation (United States)
Peter C. Chen, NASA Goddard Space Flight Center (United States)
Marcelo J. Dapino, The Ohio State University (United States)
L. Porter Davis, Honeywell Defense and Space Electronic Systems

**L. Porter Davis**, Honeywell Defense and Space Electronic Systems (United States)

Xiao-Yan Gong, Medical Implant Mechanics LLC (United States)
Holger Hanselka, Fraunhofer-Institut für Betriebsfestigkeit und
Systemzuverlässigkeit (Germany)

**Ernie Havens**, Cornerstone Research Group, Inc. (United States) **Nancy L. Johnson**, General Motors Corporation (United States) **Chad H. Joshi**, Energen, Inc. (United States)

**Jayanth N. Kudva**, NextGen Aeronautics, Inc. (United States) **Amrita Kumar**, Acellent Technologies, Inc. (United States)

Ou Ma, New Mexico State University (United States)
Geoffrey P. McKnight, HRL Laboratories, LLC (United States)
Christopher Niezrecki, University of Massachusetts Lowell
(United States)

Gyuhae Park, Chonnam National University (Korea, Republic of)
Marc E. Regelbrugge, Rhombus Consultants Group (United States)
W. Lance Richards, NASA Dryden Flight Research Center
(United States)

Eric J. Ruggiero, GE Global Research (United States)

Janet M. Sater, Institute for Defense Analyses (United States)

Henry Sodano, University of Florida (United States)

Edward V. White, The Boeing Company (United States)

#### Session Chairs

- Smart Structures Technologies for Control Gyuhae Park, Chonnam National University (Korea, Republic of)
- 2 Enabling Technologies for Embedded Sensing Kevin M. Farinholt, Commonwealth Center for Advanced Manufacturing (United States)
- 3 Aerospace ApplicationsSteven F. Griffin, Boeing LTS Inc. (United States)
- Automotive Applications
   Diann E. Brei, University of Michigan (United States)
   Marcelo J. Dapino, The Ohio State University (United States)