

PROCEEDINGS OF SPIE

# ***Health Monitoring of Structural and Biological Systems IX***

Paul Fromme  
Zhongqing Su  
*Editors*

27 April – 8 May 2020  
Online Only, United States

*Sponsored by*  
SPIE

*Cooperating Organizations*  
Jet Propulsion Laboratory (United States)

*Published by*  
SPIE

**Volume 11381**

Proceedings of SPIE 0277-786X, V. 11381

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

Health Monitoring of Structural and Biological Systems XIV, edited by Paul Fromme,  
Zhongqing Su, Proc. of SPIE Vol. 11381, 1138101 · © 2020 SPIE  
CCC code: 0277-786X/20/\$21 · doi: 10.1117/12.2572656

Proc. of SPIE Vol. 11381 1138101-1

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 [SPIDigitalLibrary.org](http://SPIDigitalLibrary.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 *Health Monitoring of Structural and Biological Systems IX*, edited by Paul Fromme, Zhongqing Su, Proceedings of SPIE Vol. 11381 (SPIE, Bellingham, WA, 2020) Seven-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510635395

ISBN: 9781510635401 (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](http://SPIE.org)

Copyright © 2020, 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 \$21.00 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](http://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/20/\$21.00.

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.

**SPIE. DIGITAL  
LIBRARY**

[SPIDigitalLibrary.org](http://SPIDigitalLibrary.org)

---

**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

---

## GUIDED WAVES FOR SHM I

---

- 11381 02      **Numerical and experimental investigation of damage detection in stiffened composite panels using guided ultrasonic waves** [11381-2]
- 11381 03      **Ultrasonic Lamb wave inspection of composite defects** [11381-3]

---

## NOVEL AND EMERGING TECHNIQUES FOR SHM I

---

- 11381 06      **Elastic wave analyzer for icy sub-surfaces (EWAIS) in water-bearing worlds** [11381-7]

---

## MONITORING OF AEROSPACE AND COMPOSITE STRUCTURES

---

- 11381 0B      **Composites impact damage detection and characterization using ultrasound and x-ray NDE techniques** [11381-13]
- 11381 0C      **Co-infused and secondary bonded composite stiffened panels in compression: numerical and experimental strength assessment combined with NDI and guided waves based SHM** [11381-14]

---

## MODELING OF ULTRASONIC AND GUIDED WAVES

---

- 11381 0H      **Simulation of guided wave under varying temperature and load conditions** [11381-19]
- 11381 0I      **Composite elastic property identification through guided wave inversion and damage detection by data-driven process** [11381-20]
- 11381 0J      **Uncertainty characterization of guided ultrasonic wave properties in composite materials** [11381-21]
- 11381 0L      **Material and geometric effects on ultrasonic guided wave propagation in long bone** [11381-23]

---

## GUIDED WAVES FOR SHM OF COMPOSITES

---

- 11381 0P      **Damage detection in laminated composites using pure SH guided wave excited by angle beam transducer** [11381-28]

- 11381 0Q      **Guided wave scattering analysis around a circular delamination in a quasi-isotropic fiber-composite laminate** [11381-29]
- 11381 0U      **Parametric studies of composite material properties influence on dispersion curves of Lamb waves** [11381-110]

---

#### MEDICAL AND BIOMEDICAL APPLICATIONS

---

- 11381 14      **Microparticle sorting with a microfluidic system and ultrasonic standing waves** [11381-43]

---

#### ELASTIC AND ACOUSTIC METAMATERIALS III

---

- 11381 17      **Reconfigurable elastic quantum valley Hall edge states in a piezoelectric topological metamaterial** [11381-47]
- 11381 18      **Acoustic metamaterial containing an array of Helmholtz resonators coupled with mass-loaded membranes** [11381-48]

---

#### GUIDED WAVES FOR SHM II

---

- 11381 1E      **Coating thickness estimation in silicon wafer using ultrafast ultrasonic measurement** [11381-55]
- 11381 1G      **Acoustic wave propagation and source localization in a 3D heterogeneous structure: a numerical study** [11381-57]

---

#### NONLINEAR ULTRASONIC TECHNIQUES

---

- 11381 1M      **Modally selective nonlinear ultrasonic waves for characterization of pitting damage in whipple shields of spacecraft** [11381-65]
- 11381 1N      **Experimental evaluation of the true intrinsic nonlinearity of rail steel using Rayleigh waves and a new nonlinearity parameter** [11381-67]

---

#### GUIDED WAVES FOR SHM III

---

- 11381 1R      **Quantitative damage estimation method based on Lamb waves for transverse damage in composite laminates** [11381-72]

---

#### CIVIL INFRASTRUCTURE MONITORING

---

- 11381 1T      Topological-based acoustic emission data analysis for passive corrosion monitoring in prestressed concrete structures [11381-74]
- 11381 1W      Vibro-acoustic modulation technique comparison with conventional nondestructive evaluation methods [11381-77]
- 11381 1Y      Building cracks identification by employing image segmentation [11381-79]
- 11381 1Z      Frequency-domain recursive hybrid GA to parameter identification of structural systems with added-damping-and-stiffness devices [11381-80]

---

#### COMPUTER VISION AND OPTICAL TECHNIQUES FOR SHM AND NDT

---

- 11381 22      Motion magnification for optical-based structural health monitoring [11381-83]
- 11381 24      3D vibration studies of large rotating structures using DIC [11381-85]
- 11381 25      Combined infrared imaging and structure from motion approach for building thermal energy efficiency and damage assessment [11381-86]

---

#### NOVEL AND EMERGING TECHNIQUES FOR SHM II

---

- 11381 28      Fiber Bragg grating sensor application for composite fast patrol boat [11381-89]
- 11381 2A      Roll threader manufacturing process control for miniature fasteners [11381-91]

---

#### SIGNAL AND DATA PROCESSING OF SENSOR DATA

---

- 11381 2I      Effect of image size on performance of a plastic gear crack detection system based convolutional neural networks: an experimental study [11381-100]
- 11381 2K      Concentrated mass localization in beam-like structures using natural frequencies [11381-102]
- 11381 2M      Additive manufacturing method application for manufacturing polymeric structure with embedded fiber Bragg grating sensor [11381-104]
- 11381 2P      Electromechanical impedance based structural health monitoring measuring system in the millisecond timescale [11381-108]

---

#### ADDITIONAL PRESENTATIONS

---

- 11381 2Q      **Evaluation of bone Electro-Mechano Gram (EMG) as a low-cost substitution of DEXA for osteoporosis detection [11381-125]**

---

#### POSTER SESSION

---

- 11381 2S      **Acoustic source localization on the surface of a cylindrical pressure vessel [11381-111]**
- 11381 2V      **Bone remodeling in additive manufactured porous implants changes the stress distribution [11381-115]**
- 11381 2X      **Method for rapid detection and treatment of cracks in tunnel lining based on deep learning [11381-117]**

---

#### ADDITIONAL PRESENTATIONS II

---

- 11381 34      **Investigation on guided waves propagation across ice layers [11381-126]**
- 11381 35      **Load and structural health monitoring of a scaled CFRP rudder stock using electro-mechanical impedance technique [11381-127]**
- 11381 36      **Guided-wave MIMO communication on a composite panel for SHM applications [11381-128]**