

PROCEEDINGS OF SPIE

***Sensors and Smart Structures
Technologies for Civil, Mechanical,
and Aerospace Systems 2023***

**Zhongqing Su
Branko Glisic
Maria Pina Limongelli**
Editors

**13–16 March 2023
Long Beach, California, United States**

Sponsored and Published by
SPIE

Volume 12486

Proceedings of SPIE 0277-786X, V. 12486

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

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.

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 2023*, edited by Zhongqing Su, Branko Glisic, Maria Pina Limongelli, Proc. of SPIE 12486, Seven-digit Article CID Number (DD/MM/YYYY); (DOI URL).

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510660793

ISBN: 9781510660809 (electronic)

Published by

SPIE

P.O. Box 10, Bellingham, Washington 98227-0010 USA

Telephone +1 360 676 3290 (Pacific Time)

SPIE.org

Copyright © 2023 Society of Photo-Optical Instrumentation Engineers (SPIE).

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 fees. To obtain permission to use and share articles in this volume, visit Copyright Clearance Center 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.

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

Paper Numbering: A unique citation identifier (CID) number is assigned to each article in the Proceedings of SPIE 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

vii *Conference Committee*

MONDAY PLENARY

12486 02 **Nature, smart structures, and morphing UAVs (Plenary Paper)** [12486-501]

ADVANCES IN SENSING TECHNOLOGY AND SYSTEM DEVELOPMENT I

12486 04 **Human trajectory estimation using analog privacy-preserving urban sensing technologies**
[12486-1]

12486 05 **Smart finger posture real-time monitoring system** [12486-2]

12486 06 **A robotic approach for crack detection through the integration of cameras and LiDARs**
[12486-4]

ADVANCES IN SENSING TECHNOLOGY AND SYSTEM DEVELOPMENT II

12486 07 **IMU-based locomotion mode identification for ankle-foot prostheses** [12486-5]

12486 08 **Nondestructive yield strength estimation for 3D-printed Ti-6Al-4V plates using eddy-current
measurement** [12486-6]

12486 09 **Open-source hardware and software for a laboratory-scale track and moving vehicle
actuation system used for indirect broken rail detection** [12486-7]

12486 0A **Underwater communication acoustic transducers: a technology review** [12486-8]

12486 0B **Image-based, structure-integrated sensor for measuring multiaxial deflection in stiff machine
elements** [12486-9]

OPTIC SENSING AND LASER TECHNOLOGY

12486 0C **Sensitization detection of aluminum alloy plates using laser-generated longitudinal waves**
[12486-11]

12486 0D **Investigate resonances of bonded Piezoelectric Wafer Active Transducer (PWaT) using laser
ultrasound excitation** [12486-12]

- 12486 OE **High-precision real-time displacement control for large optical system structure** [12486-13]
- 12486 OF **Real time traffic monitoring of pedestrian bridge using distributed fiber optic sensing textile**
[12486-14]
- 12486 OH **Analyzing the behavior of biological component aggregation in optical fibers** [12486-17]

APPLICATIONS OF SMART SENSORY SYSTEMS IN CIVIL ENGINEERING I

- 12486 OJ **Imagery-based post-flooding infrastructure damages level assessment** [12486-19]

APPLICATIONS OF SMART SENSORY SYSTEMS IN CIVIL ENGINEERING II

- 12486 OL **Robotic concrete inspection with illumination-enhancement** [12486-23]
- 12486 OM **Analysis of electric signal generated from CFRP for sensing function of smart civil engineering structures** [12486-24]
- 12486 OO **Multi-scale damage detection of glass curtain wall by acoustic emission and vibrational modal analysis** [12486-27]
- 12486 OP **Acoustic emission signatures of the high-strength concrete failure with different loading rates**
[12486-26]

DATA-DRIVEN SENSORY SYSTEMS

- 12486 OR **Sensitivity analysis of the ultrasound features for the sensitization prediction of Al-Mg alloys via Adaptive Neuro-Fuzzy Inference System (ANFIS)** [12486-29]
- 12486 OT **Stand-alone geophone monitoring system for earthen levees** [12486-31]
- 12486 OV **Time-delayed joint seismic input and state estimation for building structures using incomplete acceleration measurements** [12486-33]

NEW SENSING TECHNOLOGY FOR SHM I

- 12486 OW **Long-term ultrasonic thickness measurement on an in-service bridge through a wireless sensor network** [12486-34]
- 12486 OY **Lamb-wave and impedance based ice accretion sensing on airfoil structures** [12486-37]

12486 0Z **Actively managed battery degradation of wireless sensors for structural health monitoring**
[12486-38]

NEW SENSING TECHNOLOGY FOR SHM II

12486 10 **Structural damage identification using piezoelectric impedance sensing with enhanced optimization and enriched measurements** [12486-39]

12486 11 **Mixed regularization for damage mapping in three-dimensional self-sensing composites via EIT**
[12486-40]

12486 13 **Value of information analysis accounting for data quality** [12486-59]

AI AND MACHINE LEARNING FOR SENSING

12486 15 **Performance evaluation of an improved deep CNN-based concrete crack detection algorithm**
[12486-45]

12486 16 **Digital twin framework for real-time dynamic analysis visualization with detecting dynamic changes in structures properties using PINN** [12486-46]

12486 17 **Supervised machine learning techniques for predicting multiple damage classes in bridges**
[12486-48]

DESIGN AND FABRICATION OF SENSORY SYSTEMS I

12486 18 **Soft elastomeric capacitors with an extended polymer matrix for strain sensing on concrete**
[12486-49]

12486 1B **On the performance of PVDF based piezoelectric sensor with microstructures** [12486-53]

DESIGN AND FABRICATION OF SENSORY SYSTEMS II

12486 1C **Automated manufacturing of smart tunnel segment** [12486-54]

12486 1E **Satellite InSAR technology for structural health monitoring of road bridges and the surrounding territory: a case study** [12486-20]

12486 1G **DIC system with Euler transformation for structural measurements in wind tunnel** [12486-58]

MODELING OF SMART SENSORS AND SYSTEMS

- 12486 1H **Scientific evaluation of ultrasonic sensors for use in applications of water and hydraulic monitoring** [12486-60]
- 12486 1J **Wave-based sensor responses with embedded electrode layouts** [12486-63]

SIGNAL AND IMAGE PROCESSING

- 12486 1L **A novel directional lighting algorithm for concrete crack pixel-level segmentation** [12486-65]
- 12486 1M **Non-linear vibration signal compensation technique for UAV-deployable sensor packages with edge computing** [12486-66]
- 12486 1N **Impact damage imaging for composite structures using guided wave techniques with 3D digital image correlation** [12486-67]
- 12486 1O **Gaussian process regression surrogate model for dynamic analysis to account for uncertainties in seismic loading** [12486-68]
- 12486 1P **Applying the modified adaptive window sizes into the image segmentation to identify defects from thermal infrared images covered with intensity inhomogeneity** [12486-69]
- 12486 1Q **A new methodology to prioritize non-destructive evaluation based on risk conditions and costs assessment in the context of limited information** [12486-70]

POSTER SESSION

- 12486 1R **Distributed optic fiber sensing textile installation inside a novel composite girder bridge** [12486-71]

DIGITAL POSTER SESSION

- 12486 1T **Cable-stayed bridge sensor optimization based on modal information incremental matrix of the covariance matrix** [12486-62]