

PROCEEDINGS OF SPIE

International Conference on Optical and Photonic Engineering (icOPEN 2023)

**Haixia Wang
Fang Cheng
Cuong Dang
Aaron Danner
Qian Kemao**
Editors

**27 November – 1 December 2023
Singapore**

Organized by
Optics and Photonics Society of Singapore (Singapore)

Co-Organized by
The Advanced Remanufacturing and Technology Centre, A*STAR (Singapore)
The Singapore Institute of Manufacturing Technology, A*STAR (Singapore)
Nanjing University of Science and Technology, NJUST (China)

Sponsored by
Axecon (Singapore)
Shenzhen Anhua Optoelectronics Technology Company Ltd. (China)
Meta-Bounds (China)
Wavelength Opto-Electronic(s) Pte Ltd. (China)

Published by
SPIE

Volume 13069

Proceedings of SPIE 0277-786X, V. 13069

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

International Conference on Optical and Photonic Engineering (icOPEN 2023), edited by Haixia Wang,
Fang Cheng, Cuong Dang, Aaron Danner, Qian Kemao, Proc. of SPIE Vol. 13069, 1306901
© 2024 SPIE · 0277-786X · doi: 10.1117/12.3027750

Proc. of SPIE Vol. 13069 1306901-1

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.

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 *International Conference on Optical and Photonic Engineering (icOPEN 2023)*, edited by Haixia Wang, Fang Cheng, Cuong Dang, Aaron Danner, Qian Kemao, Proc. of SPIE 13069, Seven-digit Article CID Number (DD/MM/YYYY); (DOI URL).

ISSN: 0277-786X
ISSN: 1996-756X (electronic)

ISBN: 9781510674561
ISBN: 9781510674578 (electronic)

Published by
SPIE
P.O. Box 10, Bellingham, Washington 98227-0010 USA
Telephone +1 360 676 3290 (Pacific Time)
SPIE.org
Copyright © 2024 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*

3D MEASUREMENT

- | | |
|----------|---|
| 13069 02 | Dataset enhancement training of diffraction model-driven neural networks and extension to generate multi-depth computer-generated holograms [13069-30] |
| 13069 03 | Real-time 3D acquisition method for light field 3D display [13069-81] |
| 13069 04 | Measurement depth modeling and extension for geometric constraint phase unwrapping method [13069-23] |
| 13069 05 | Towards building information modeling based on FPP-SLAM [13069-34] |
| 13069 06 | Adaptive-resolution-based high-resolution indoor 3D perceiving in fringe projection profilometry [13069-35] |
| 13069 07 | Body measurement based on a multiview structured light 3D imaging system [13069-53] |
| 13069 08 | Point cloud pair constraint registration algorithm based on directed distance function [13069-46] |
| 13069 09 | UAV-based 3D infrared imaging of terrestrial constructions [13069-48] |
| 13069 0A | A calibration method for LED point light sources in near-field photometric stereo [13069-45] |

COMPUTER VISION AND DEEP LEARNING

- | | |
|----------|---|
| 13069 0B | Active thermal marker using thermal images of heated areas with visible semiconductor laser [13069-33] |
| 13069 0C | Single-shot microscopic autofocus focusing on image detail features [13069-17] |
| 13069 0D | CycleSR: unsupervised learning for 3D fingerprint super-resolution [13069-32] |
| 13069 0E | Design of point cloud data structures for efficient processing of large-scale point clouds [13069-54] |

- 13069 OF **Research on dimension measurement based on 3D point cloud** [13069-57]
- 13069 OG **A two-stage deep learning method for foreign object detection and localization** [13069-79]

DIGITAL HOLOGRAPHY AND MOIRÉ

- 13069 OH **Engineering axial resolution realtime and postrecording of incoherent holograms using hybridization techniques** [13069-1]
- 13069 OI **Digital holography with deep learning for algae identification and classification** [13069-26]
- 13069 OJ **Multiple-image authentication scheme based on the phase-only holograms** [13069-38]
- 13069 OK **Unpaired learning for digital holographic reconstruction and generation** [13069-47]
- 13069 OL **Application of moiré method for defect detection and strain imaging of silicon single crystals** [13069-64]
- 13069 OM **Microscale strain distribution measurement before and after crack and delamination occurrence in CFRP laminates by multiplication sampling moiré method** [13069-66]
- 13069 ON **Validating the efficacy of deformation distribution measurement in CFRP laminates during three-point bending using the sampling moiré method** [13069-69]
- 13069 OO **Bridge deflection measurement by drone aerial photography using the sampling moiré method** [13069-62]

OPTICAL IMAGING

- 13069 OP **3D quantitative phase imaging of human red blood cells** [13069-73]
- 13069 OQ **Secured optical data transmission through dynamic scattering media using pixel-to-plane optical data encoding** [13069-14]
- 13069 OR **Optical pixel-to-plane encoding with neural network for ghost transmission through complex scattering media** [13069-15]
- 13069 OS **Random encoding with a modified Gerchberg-Saxton algorithm for accurate ghost transmission through complex scattering media** [13069-16]
- 13069 OT **An optical image encryption method based on Fourier single-pixel imaging and phase retrieval algorithm** [13069-37]
- 13069 OU **High-quality object reconstruction based on single-pixel imaging in highly dynamic scattering environments** [13069-5]

OPTICAL MEASUREMENT

- | | |
|----------|--|
| 13069 0V | Suppression of speckle noise in laser Doppler vibrometry by signal diversity and dynamic ellipse fitting [13069-25] |
| 13069 0W | Hyperspectral anomaly detection based on background purification and spectral feature extraction [13069-78] |
| 13069 0X | Uncertainty analysis and optimization design of long-distance laser triangulation displacement sensor applied to dynamic object [13069-2] |
| 13069 0Y | 3D measurement of large and complex parts based on phase matching and global marker points registration [13069-21] |
| 13069 0Z | Quality inspection and assembly sequence optimization of revolved thin-walled parts based on point clouds [13069-56] |
| 13069 10 | Parametric studies of liquid LIBS for agricultural applications [13069-76] |

OPTICAL MEASUREMENT AND INSTRUMENTATION

- | | |
|----------|---|
| 13069 11 | Development of a vision system for cast mould defect inspection under extreme high temperatures [13069-22] |
| 13069 12 | Zernike polynomials fitting of arbitrary shape wavefront [13069-28] |
| 13069 13 | Speckle pattern interferometry excited by pulsed laser for crack size detection [13069-29] |
| 13069 14 | Fast anti-turbidity underwater topography measurement based on rotating structured light [13069-31] |
| 13069 15 | Stitching in fixed wide-field-of-view scenarios [13069-39] |
| 13069 16 | Phase retrieval by extracting Zernike coefficients from two random phase-shifting interferograms based on deep learning [13069-52] |
| 13069 17 | Phase shift error estimation based on deep learning [13069-80] |

X-RAY OPTICS, NDT AND OTHERS

- | | |
|----------|---|
| 13069 18 | X-ray optics development and metrology at Shanghai synchrotron radiation facility [13069-60] |
| 13069 19 | Transformer-based smart inspection for agricultural products via x-ray images [13069-71] |

- 13069 1A **Development of stress-free Laue diffraction crystal for x-ray beam splitting [13069-8]**
- 13069 1B **Feasibility of in-situ health monitoring for composite structure with embedded piezoelectric sensor networks [13069-24]**
- 13069 1C **Improved video motion magnification method assisted by digital image correlation [13069-43]**
- 13069 1D **A simulation on quasi-phase-matched high-harmonic generation in gas-filled hollow core waveguide [13069-27]**
- 13069 1E **In-house developed ultra-sensitive laser stimulated fluorescence system for amino acid profiling [13069-74]**
- 13069 1F **Uniform LIPSS on copper created using zeroth-order femtosecond Bessel beam for SERS-based applications [13069-3]**

Conference Committee

General Chair

Anand Asundi, d'Optron Pte Ltd. (Singapore)

Co-chairs

Qian Kemao, Nanyang Technological University (Singapore)

Fang Cheng, Advanced Remanufacturing and Technology Centre,
A*STAR (Singapore)

Cuong Dang, Nanyang Technological University (Singapore)

Aaron Danner, National University of Singapore (Singapore)

Haixia Wang, Zhejiang University of Technology (China)

Session Chairs

- 1 Plenary 1: Testing Optics with Interferometry and Tunable-Wavelength Lasers
Fang Cheng, Advanced Remanufacturing and Technology Centre,
A*STAR (Singapore)
- 2 Plenary 2: Digital Holographic Metrology for Imaging Acoustics and Vibrations
Fang Cheng, Advanced Remanufacturing and Technology Centre,
A*STAR (Singapore)
- 3 Plenary 3: Publishing in Nature Journals
Chao Zuo, Nanjing University of Science and Technology (China)
- 4 Plenary 4: Advances in High-Accuracy Three-Dimensional Dynamic Deformation Measurement and its Applications for Large Structures
Chao Zuo, Nanjing University of Science and Technology (China)
- 5 Keynote 1: Specular Surface Shape Measurement with Collimated Phase Measuring Deflectometry
Cuong Dang, Nanyang Technological University (Singapore)
- 6 Keynote 2: The Slope Deflectometry System Development for Three-Dimensional Profile Measurement
Cuong Dang, Nanyang Technological University (Singapore)

- 7 Keynote 3: Sub-10 nm Focusing of Hard X-ray Free-Electron Laser for Reaching 10^{22} W/cm² Intensity
Cuong Dang, Nanyang Technological University (Singapore)
- 8 Keynote 4: Three-Dimensional Shape Measurement of Diffused/Specular Surface by Combining Fringe Projection Profilometry and Phase Measuring Deflectometry
Haixia Wang, Zhejiang University of Technology (China)
- 9 Keynote 5: Quantitative Phase Microscopy and Phase Correlation Spectroscopy for Biology
Haixia Wang, Zhejiang University of Technology (China)
- 10 Keynote 6: Research on Single Pixel Imaging Method for Moving Object
Haixia Wang, Zhejiang University of Technology (China)
- 11 SS1: 2D, 3D and Volumetric Digital Image Correlation and their Applications
Zhenyu Jiang, South China University of Technology (China)
- 12 SS2: 3D Shape Measurement Based on Fringe Projection
Dongliang Zheng, Nanjing University of Science and Technology (China)
- 13 SS3: Advances in Digital Holography Techniques
Peng Gao, Xidian University (China)
- 14 SS4: Advances in Moiré Method and its Applications
Hongye Zhang, Beijing Forestry University (China)
- 15 SS7: High-Accuracy Optical Deformation Measurement of Large Engineering Structures
Xinxing Shao, Southeast University (China)
Qinwei Ma, Beijing Institute of Technology (China)
- 16 SS8: High-Precision Optical Measurement
Xiangchao Zhang, Fudan University (China)
- 17 SS9: Imaging Through Scattering Media and Non-line-of-sight Imaging
Jing Han, Nanjing University of Science and Technology (China)
- 18 SS10: Industrial Optical Inspection and Non-Destructive Testing (NDT)
Joseph Liffon, Advanced Remanufacturing and Technology Center (Singapore)
Tong Liu, Singapore Institute of Manufacturing Technology (Singapore)

- 19 SS12: Micro/Nano-Mechanical Measurement and Characterization by Optical/Spectral Methods
Wei He, Hunan University (China)
- 20 SS13: Optical Dynamic Measurement
Yu Fu, Shenzhen University (China)
- 21 SS14: Optical Measurement and Instrumentation
Yingjie Yu, Shanghai University (China)
- 22 SS15: Quantitative Phase Imaging
Chao Zuo, Nanjing University of Science and Technology (China)
- 23 SS16: Single-Pixel Imaging and Optical Encoding
Wen Chen, Hong Kong Polytechnic University (China)
- 24 SS17: Infrared Thermography and Structural Health Monitoring
Hongye Zhang, Beijing Forestry University (China)
- 25 SS18: X-ray Optics and Metrology
Lei Huang, Brookhaven National Laboratory (United States)
Jumpei Yamada, Osaka University (Japan)
- 26 SS19: Optical Engineering in Industry
Qionghua Wang, Beihang University (China)
- 27 GT1: 3D Image Acquisition and Display
Wen Chen, Hong Kong Polytechnic University (China)
- 28 GT2: Biomedical Optics and Imaging
Yongtao Liu, Nanjing University of Science and Technology (China)
- 29 GT3: Computer Vision Techniques
Yongtao Liu, Nanjing University of Science and Technology (China)
- 30 GT6: Image Processing and Deep Learning
Liyong Ren, Shaanxi Normal University (China)
- 31 GT9: Non-Destructive Testing and Inspection
Chenxing Wang, Southeast University (China)
- 32 GT10: Optical Component and System Simulation
Zhenyu Jiang, South China University of Technology (China)
- 33 GT11: Optical Functional Materials and Devices
Chenxing Wang, Southeast University (China)

- 34 GT12: Optical Measurement Methods
Satoru Yoneyama, Aoyama Gakuin University (Japan)
Fujun Yang, Southeast University (China)
- 35 GT13: Quantitative Phase Imaging
Liangcai Cao, Tsinghua University (China)
- 36 GT15: Ultrafast Lasers and Applications
Zhenyu Jiang, South China University of Technology (China)
- 37 GT16: Other Related Topics
Qionghua Wang, Beihang University (China)

Special Session Organizers

- 1 SS1: 2D, 3D and Volumetric Digital Image Correlation and their Applications
Zhenyu Jiang, South China University of Technology (China)
- 2 SS2: 3D Shape Measurement based on Fringe Projection
Dongliang Zheng, Nanjing University of Science and Technology (China)
- 3 SS3: Advances in Digital Holography Techniques
Jianglei Di, Guangdong University of Technology (China)
- 4 SS4: Advances in Moiré Method and its Applications
Hongye Zhang, Beijing Forestry University (China)
Xianfu Huang, Institute of Mechanics, Chinese Academy of Sciences (China)
- 5 SS7: High-Accuracy Optical Deformation Measurement of Large Engineering Structures
Xinxing Shao, Southeast University (China)
Banglei Guan, National University of Defense Technology (China)
Qinwei Ma, Beijing Institute of Technology (China)
- 6 SS8: High-Precision Optical Measurement
Jing Xu, Tsinghua University (China)
Xiangchao Zhang, Fudan University (China)
Wenlong Lu, Huazhong University of Science and Technology (China)
- 7 SS9: Imaging through Scattering Media and Non-line-of-sight Imaging
Jing Han, Nanjing University of Sciences and Technology (China)
- 8 SS10: Industrial Optical Inspection and Non-Destructive Testing (NDT)
Andrew Alexander Malcolm, Advanced Remanufacturing and Technology Center (Singapore)

Joseph Lifton, Advanced Remanufacturing and Technology Center
(Singapore)

- 9 SS12: Micro/Nano-Mechanical Measurement and Characterization of
Optical/Spectral Methods
Mengxiong Liu, Peking University (China)
Haimei Xie, Tianjin University (China)
Xide Li, Tsinghua University (China)
- 10 SS13: Optical Dynamic Measurement
Yu Fu, Shenzhen University (China)
- 11 SS14: Optical Measurement and Instrumentation
Yingjie Yu, Shanghai University (China)
- 12 SS15: Quantitative Phase Imaging
Chao Zuo, Nanjing University of Science and Technology (China)
- 13 SS16: Single-Pixel Imaging and Optical Encoding
Wen Chen, The Hong Kong Polytechnic University (China)
Zibang Zhang, Jinan University (China)
- 14 SS17: Infrared Thermography and Structural Health Monitoring and
Evaluation
Jianguo Zhu, Jiangsu University (China)
Dan Wu, Ningbo University (China)
- 15 SS18: X-ray Optics and Metrology
Lei Huang, Brookhaven National Laboratory (United States)
- 16 SS19: Optical Engineering in Industry
Anand Asundi, d'Optron Pte Ltd. (Singapore)
Xiang Peng, Shenzhen University (China) and Shenzhen Anhua
Optoelectronics Technology Company Ltd. (China)

