## PROCEEDINGS OF SPIE

# Optical Metrology and Inspection for Industrial Applications X

Sen Han Gerd Ehret Benyong Chen Editors

15–16 October 2023 Beijing, China

Sponsored by SPIE COS—Chinese Optical Society

Cooperating Organizations

Tsinghua University (China) • Peking University (China) • University of Science and Technology of China (China) • Zhejiang University (China) • Tianjin University (China) • Beijing Institute of Technology (China) Beijing University of Posts and Telecommunications (China) • Nankai University (China) • Changchun University of Science and Technology (China) • University of Shanghai for Science and Technology (China) • Capital Normal University (China) • Huazhong University of Science and Technology (China) Beijing Jiaotong University (China) • China Jiliang University (China) • Shanghai Institute of Optics and Fine Mechanics, CAS (China) • Changchun Institute of Optics, Fine Mechanics and Physics, CAS (China) Institute of Semiconductors, CAS (China) • Institute of Optics and Electronics, CAS (China) • Institute of Physics, CAS (China) • Optical Society of Japan (Japan) • Optical Society of Korea (Republic of Korea) Australian and New Zealand Optical Society • Optics and Photonics Society of Singapore (Singapore) • European Optical Society

Supporting Organizations China Association for Science and Technology (CAST) (China) Department of Information of National Nature Science Foundation, China (NSFC) (China)

Published by SPIE

Volume 12769

Proceedings of SPIE 0277-786X, V. 12769

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 SPIEDigitalLibrary.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 Optical Metrology and Inspection for Industrial Applications X, edited by Sen Han, Gerd Ehret, Benyong Chen, Proc. of SPIE 12769, Seven-digit Article CID Number (DD/MM/YYYY); (DOI URL).

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

ISBN: 9781510667877 ISBN: 9781510667884 (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.



**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 Symposium Committee
- xi Conference Committee

#### **OPTICAL METROLOGY METHODS I**

12769 03	Guided filtering based surface recovery algorithm for white light interferometry [12769-2]
12769 04	Long binary coding design for absolute positioning using genetic algorithm [12769-4]
12769 05	High-speed spectral confocal signal collection method based on acquisition and tracking algorithm with variable window-width [12769-5]
12769 06	Spectral interferometry for thin film information by fitting Fourier transform spectrum [12769-6]

#### OPTICAL METROLOGY METHODS II

12769 09 Optical method for depth measurement of high aspect ratio 3D microstructure [12769-9]

#### **OPTICAL METROLOGY METHODS III**

12769 OB	Comprehensive advancements in automatic digital manufacturing of spherical and aspherical optics (Invited Paper) [12769-11]
12769 OC	Improved dispersion-coded full-range spectral interferometry for large-depth samples [12769-12]
12769 OD	Fast calibration based photometric stereo for multiscale metallic surface measurement [12769-13]
12769 OE	High-quality super-resolution lensless imaging with Fresnel zone aperture [12769-14]
	OPTICAL METROLOGY METHODS IV

12769 OF	Full-field modeling and calibration of 3D interference fringe volume with line-shaped Gaussian beam intersection (Invited Paper) [12769-15]
12769 OH	Measurement and analysis of a 4"-18" aperture dual-beam Fizeau interferometer [12769-17]

#### **OPTICAL METROLOGY METHODS V**

12769 OJ	Automated sampling path planning model for complex surface of cylinder gear based on laser scanning techniques [12769-20]
12769 OK	Error compensation for form errors of plate beamsplitter in near optical coaxial phase measuring deflectometry with reflection error model [12769-21]
12769 OL	Mid-spatial frequency error measurement of large aperture lenses [12769-22]
12769 OM	A deep-learning approach for rapid prediction of spectral responses of meta-atoms [12769-23]
12769 ON	Analysis of vibration causes of large aperture wafer under vertical support [12769-24]
	OPTICAL METROLOGY APPLICATIONS I

- 12769 OP Spectral analysis algorithm of vibration effect in phase-shifting interferometry (Invited Paper) [12769-26]
- 12769 0Q Dynamic angle measurements involving different optical null-indicator types (Invited Paper) [12769-27]

#### **OPTICAL METROLOGY APPLICATIONS II**

- 12769 OT Single-shot dispersive interferometry for inline surface inspection [12769-31]
- 12769 OU Dynamic combined measurement of multiple laser trackers and application [12769-32]
- 12769 OV Optimization of adaptive digital fringe method in PMD [12769-33]
- 12769 OW Geometric characteristics measurement technique for film cooling holes based on spectral interferometry system [12769-34]

#### **OPTICAL METROLOGY APPLICATIONS III**

12769 OY Evaluation of atmospheric temperature uncertainty caused by platform attitude fluctuation [12769-36]

12769 10 Codes coupling optimization for absolute measurement [12769-38]

12769 11 Frequency modulation continuous wave speed-distance synchronous measurement with variable period frequency parameter estimation traced to optical frequency comb [12769-40]

#### POSTER SESSION

12769 12	A quantitative reconstruction method for background-oriented Schlieren by reducing the weight matrix [12769-41]
12769 13	Angular determination algorithm for three-dimensional autocollimation measurements [12769-42]
12769 16	Analysis of defocus error on the absolute measurement of spherical surface [12769-45]
12769 17	Efficient GPU acceleration for phase unwrapping algorithm [12769-46]
12769 18	Bat-wing elimination algorithm based on the CNN in white-light interferometry [12769-47]
12769 1A	Multi-wavelength laser interferometer control system design [12769-49]
12769 1D	Analysis of autocollimator measurement system based on quaternion algorithm for 6-DOF [12769-52]
12769 1F	Swing-arm profilometer design for high steepness optical aspheric surfaces [12769-54]
12769 1G	An extended light source based on multimode fiber in interferometers [12769-55]
12769 1H	A smartphone-based device for automatically calibrating wave-front systematical error [12769-56]
12769 1J	An iterative reconstruction method for photoacoustic tomography in heterogeneous media based on point source response [12769-58]
12769 1K	Novel parallel measurement method of spectral confocal sensor with multi-point scanning [12769-64]

#### DIGITAL POSTER SESSION

- 12769 1N Algorithm for detection and classification of small objects on a complicated background to automated robotic complex [12769-19]
- 12769 10 Preprocessing and classification of objects based on neural network models built using memristors' elements [12769-39]

- 12769 1P New indicators and standards for measuring of the end mill's helical groove by image processing [12769-59]
- 12769 1Q Deep learning-based depth map defect removal for industrial applications [12769-60]
- 12769 1R Attention map-guided multi-scale haze removal method for industrial inspection system [12769-61]
- 12769 1S Planning the trajectory of an object in a confined space using stationary machine vision systems [12769-62]
- 12769 11 Combining tensometric and video data in solving problems of eliminating dynamic effects during the movement of a manipulator with flexible links [12769-63]