Unconventional Imaging, Sensing, and Adaptive Optics 2024

Jean J. Dolne Santasri R. Bose-Pillai Matthew Kalensky Editors

19–23 August 2024 San Diego, California, United States

Sponsored and Published by SPIE

Volume 13149

Proceedings of SPIE 0277-786X, V. 13149

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 Unconventional Imaging, Sensing, and Adaptive Optics 2024, edited by Jean J. Dolne, Santasri R. Bose-Pillai, Matthew Kalensky, Proc. of SPIE 13149, Seven-digit Article CID Number (DD/MM/YYYY); (DOI URL).

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

ISBN: 9781510679580 ISBN: 9781510679597 (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.



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

ix Conference Committee

UNCONVENTIONAL IMAGING I

- 13149 02 AB-stacked bilayer graphene for hyperspectral LWIR imaging [13149-1]
- 13149 03 Initial information content analysis of shadow imaging of GEO satellites [13149-3]
- 13149 04 Shadow imagery initial field testing progress [13149-4]

UNCONVENTIONAL IMAGING II

13149 05 Artifacts in single pixel imaging of complex light fields [13149-10]

UNCONVENTIONAL IMAGING III

- 13149 06 Active imaging testbed development and field studies of SWIR and eSWIR active imaging [13149-11]
 13149 07 Time-varying implicit neural representations for unsupervised speckle denoising in dynamic scenes [13149-12]
 13149 08 Novel approach to coherent imaging in the presence of speckle noise [13149-13]
 13149 09 Illumination power requirements for an MCT APD vs. a COTS camera at 1.645um [13149-14]
 AERO EFFECTS I
- 13149 0A Data-driven synthetic wavefront generation for boundary layer data [13149-17]
- 13149 OB Optical and thermal effects of a species-mismatched supersonic mixing layer formed over a cooled optical window [13149-18]

AERO EFFECTS II

13149 OC Parametric studies of effects of finite pixel and AOI sizes on the accuracy of Shack-Hartmann WFS [13149-22]

- 13149 0D Image sharpening for lower order and quasi-static aero-optic wavefront compensation [13149-23]
- 13149 OE Preliminary aero-mechanical jitter analysis of hemispherical turrets [13149-24]
- 13149 OF Phase discontinuity classification from single-aperture irradiance patterns using machine learning [13149-25]

UNCONVENTIONAL ADAPTIVE OPTICS I

- 13149 0G Laboratory experiments on multiconjugate adaptive optics for compensation of strong turbulence [13149-29]
- 13149 0H Tuning the MAPS adaptive secondary mirror: actuator control, PID tuning, power spectra, and failure diagnosis [13149-30]

UNCONVENTIONAL ADAPTIVE OPTICS II

- 13149 01 Image correction and wavefront sensing with a digital holographic sensor using implicit neural representations [13149-32]
- 13149 0J Deep turbulence sensing using digital holography [13149-33]
- 13149 OK Wavefront sensing requirements for high-speed AO in deep turbulence (Invited Paper) [13149-35]

ATMOSPHERIC MODELING AND CHARACTERIZATION I

- 13149 OL Modern bandwidth requirements in active tracking (Invited Paper) [13149-36]
- 13149 0M Analysis of terrestrial free-space optical links with wide-band super continuum lasers and incoherent beam combining [13149-37]
- 13149 0N Simulation of wave propagation through turbulent media utilizing the split-step beam propagation method incorporating light attenuation due to aerosol scatter [13149-42]

ATMOSPHERIC MODELING AND CHARACTERIZATION II

- 13149 00 Methods and considerations for generating realistic synthetic imagery in optical tracking of extended targets (Invited Paper) [13149-40]
- 13149 OP Simulating speckle fields in deep turbulence via wave optics: angular spectrum method versus sinc-basis propagation [13149-41]

| 13149 0Q | Scintillation-induced centroid | jitter: analyt | tical solutions | [13149-38] | L |
|----------|--------------------------------|----------------|-----------------|------------|---|
|----------|--------------------------------|----------------|-----------------|------------|---|

- 13149 OR Novel methods for dynamic simulations of optical propagation through atmospheric turbulence [13149-43]
- 13149 0S Split-step modeling for coherent imaging (Invited Paper) [13149-44]

ATMOSPHERIC MODELING AND CHARACTERIZATION III

- 13149 OT Frodo, a daytime atmospheric turbulence monitor, demonstrated in the ASALT lab [13149-45]
- 13149 0U An assessment of the energy balance Bowen ratio method to quantify optical turbulence in the maritime environment [13149-47]
- 13149 OV Atmospheric characterization and profiling with ProfilerTools [13149-86]

ATMOSPHERIC MODELING AND CHARACTERIZATION IV

- 13149 OW Comparative evaluation of optical turbulence and extinction instruments to high-energy laser atmospheric propagation (Invited Paper) [13149-49]
- 13149 0X Profiling RATS generated turbulence with SMASH [13149-50]

ATMOSPHERIC MODELING AND CHARACTERIZATION V

- 13149 0Y Predicting atmospheric turbulence (Cn2) with deep neural networks: leveraging laser beam phase and turbulence profiling (Invited Paper) [13149-53]
- 13149 0Z Branch point detection in SMASH measurements using second-moment wavefront sensor statistics [13149-54]
- 13149 10 Comparison of Shack-Hartmann and digital holographic wavefront sensing using a benchtop turbulence generator [13149-55]
- 13149 11 Shack-Hartmann characterization of atmospheric turbulence simulated with the reflective atmospheric turbulence simulator [13149-56]

UNCONVENTIONAL IMAGING IV

- 13149 12 Quantifying effluent flow with event-based sensors [13149-57]
- 13149 13 Progress on event-based camera characterization techniques including pre-launch measurements of the Falcon ODIN space experiment [13149-58]

- 13149 14 Falcon ODIN: an event-based camera payload [13149-60]
- 13149 15 A learning-based approach to event-based Shack-Hartmann wavefront sensing [13149-61]

UNCONVENTIONAL SENSING I

| 13149 16 | Economic and lightweight radiation mapping: using mmWave radar and lidar-trained |
|----------|--|
| | Pix2Pix cGAN to create 2D indoor maps for radiation localization [13149-63] |
| | |

- 13149 17 Fiber-based interferometer for seismic detection [13149-64]
- 13149 18 Development of hyperspectral polarimetry of geosynchronous satellites [13149-65]
- 13149 19 Prospect for cislunar spacecraft and near-earth asteroid detection using heliostat fields at night [13149-66]
- 13149 1A Illumination is all it takes: on the detection of objects embedded in scattering media via multi-wavelength speckle correlation [13149-67]

UNCONVENTIONAL SENSING II

- 13149 1B A discussion of performance metric standards for free space optical communications systems [13149-68]
- 13149 1C Image blur due to aerosols and correlation with aerosol morphology and optical properties [13149-69]
- 13149 1D Measuring bulk angular scattering in atmospherically relevant degraded visual environments [13149-70]
- 13149 1E Mitigating atmospheric turbulence using homodyne interferometry [13149-71]

UNCONVENTIONAL SENSING III

- 13149 1G Branch-point compensation in extended-beacon adaptive optics [13149-74]
- 13149 1H Phase retrieval of a point spread function [13149-75]
- 13149 11 Characterization of point-source transient events with a rolling-shutter compressed sensing system [13149-76]
- 13149 1J Implementation of reference-less wavefront sensing in a grating array-based wavefront sensor [13149-77]

13149 1K Minnaert resonance analysis and Poincaré maps to detect gas in Wellbore using fiber-optic sensor data [13149-78]

POSTER SESSION

- 13149 1L Adapting the Super-LOTIS optical telescope for ground-based NUV observations of transients [13149-83]
- 13149 1M Polarization analysis of Fizeau-type Y-4 prototype [13149-84]