PROCEEDINGS OF SPIE

SPIDigitalLibrary.org/conference-proceedings-of-spie

Front Matter: Volume 9948

, "Front Matter: Volume 9948," Proc. SPIE 9948, Novel Optical Systems Design and Optimization XIX, 994801 (22 November 2016); doi: 10.1117/12.2263017

SPIE.

Event: SPIE Optical Engineering + Applications, 2016, San Diego, California, United States

PROCEEDINGS OF SPIE

Novel Optical Systems Design and Optimization XIX

Arthur J. Davis
Cornelius F. Hahlweg
Joseph R. Mulley
Editors

29–30 August 2016
San Diego, California, United States

Sponsored and Published by
SPIE

Volume 9948

Proceedings of SPIE 0277-786X, V. 9948

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

Novel Optical Systems Design and Optimization XIX, edited by Arthur J. Davis, Cornelius F. Hahlweg,
Joseph R. Mulley, Proc. of SPIE Vol. 9948, 994801 · © 2016 SPIE
CCC code: 0277-786X/16/\$18 · doi: 10.1117/12.2263017

Proc. of SPIE Vol. 9948 994801-1

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 *Novel Optical Systems Design and Optimization XIX*, edited by Arthur J. Davis, Cornelius F. Hahlweg, Joseph R. Mulley, Proceedings of SPIE Vol. 9948 (SPIE, Bellingham, WA, 2016) Six-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510602878

ISBN: 9781510602885 (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

Copyright © 2016, 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 \$18.00 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. 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/16/\$18.00.

Printed in the United States of America.

Publication of record for individual papers is online in the SPIE Digital Library.

**SPIE. DIGITAL
LIBRARY**

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 six-digit CID article numbering system structured as follows:

- The first four 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	<i>Authors</i>
ix	<i>Conference Committee</i>
xi	<i>Introduction</i>

SESSION 1 DISPLAYS

9948 02	Glasses-free 2D-3D switchable display using an integrated single light guide plate [9948-1]
9948 03	Color transparent screen using planar glass combined with lens array holographic optical elements [9948-2]

SESSION 2 OPTIMIZATION/SIMULATION

9948 04	Applying Q-type aspheres in the ultraviolet lithography objective lens [9948-3]
9948 05	Athermalization and achromatization of multiband optics using instantaneous Abbe number [9948-4]
9948 06	The role of aberrations in the relative illumination of a lens system [9948-5]
9948 07	Advancements in multi-objective and surrogate-assisted GRIN lens design and optimization [9948-6]
9948 08	Photography at relativistic speeds [9948-7]

SESSION 3 HYPERSPECTRAL/UV/IR SYSTEMS

9948 09	Chip-size wavelength detector based on a gradient grating period guided-mode resonance filter [9948-8]
9948 0A	Fast and robust pushbroom hyperspectral imaging via DMD-based scanning [9948-9]
9948 0B	Design, implementation and performance analysis of cooled infrared cameras with single FPA depth estimation capabilities [9948-10]

SESSION 4 INSTRUMENTATION AND CAMERA SYSTEMS

9948 0D	Towards 3D printed confocal endoscopy [9948-12]
---------	--

- 9948 OE **Ultrasensitive laser wave-mixing spectroscopic method for detection and separation of biomarkers and carcinogenic pollutants** [9948-13]
- 9948 OF **Challenges in system design of an optronic, laser-based measurement system for projectile trajectories (Invited Paper)** [9948-14]
- 9948 OI **Design, construction and testing of lateral transfer retroreflectors for space-based applications** [9948-17]

SESSION 5 FREEFORM AND UNCONVENTIONAL OPTICS

- 9948 OJ **Determination of mean square deviation of surface roughness in a planar gradient optical waveguide** [9948-18]
- 9948 OK **Improving spectrometer field of view correction with a freeform surface** [9948-19]
- 9948 OL **Discussing design for manufacturability for two freeform imaging systems** [9948-20]
- 9948 OM **Design of compact optical systems using multichannel configurations** [9948-21]
- 9948 ON **Resolution limits of pixellated optical components** [9948-22]
- 9948 OO **Digital integral cloaking** [9948-23]

SESSION 6 PHOTONICS AND LASERS

- 9948 OP **Design and analysis of chirped photonic crystal waveguide based optical diode** [9948-24]
- 9948 OQ **Inverse-designed all-dielectric waveguide bend** [9948-25]
- 9948 OS **Laser stabilization in atom lithography based on LIF signal from the chromium beam** [9948-27]

SESSION 7 COMPUTATIONAL IMAGING

- 9948 OT **Design and calibration of a wide field of view MWIR optically multiplexed imaging system** [9948-28]
- 9948 OU **Multiple beam ptychography for large field of view imaging** [9948-29]

SESSION 8 OPTICS AND SOUND

- 9948 OW **Modeling of an optocoupler-based audio dynamic range control circuit** [9948-31]
- 9948 OX **Generation of rhythm patterns from harmonic structures in power modulated light** [9948-32]
- 9948 OY **Optical techniques for sound processing (Invited Paper)** [9948-33]

POSTER SESSION

- 9948 0Z **A refractometer based on a sinusoidal grating** [9948-35]
- 9948 11 **Graphical selection of optical glasses using iterative method from an expanded athermal glass map for an athermal and achromatic design** [9948-37]
- 9948 13 **Parallel compressed sensing super-resolution imaging via using multiply scattering medium** [9948-39]
- 9948 14 **Methods of optimizing the speed and accuracy of optical complex guidance systems based on equivalence of automatic control system domain of attraction and unconditional stability of their equivalent circuits** [9948-40]
- 9948 15 **A novel high spatial resolution recording method of far-infrared digital hologram based on vanadium dioxide film** [9948-41]
- 9948 18 **Stereo matching image processing by the fixed pixels period sampling edge detection and the characteristic band area construction** [9948-44]
- 9948 1A **Optical design of three-dimensional digital ophthalmoscopes** [9948-46]
- 9948 1B **Compact wide-field off-axis two-mirror system with field corrector** [9948-47]
- 9948 1C **A novel method to optimize a Galvo-Scanner used in optical imaging systems to minimize the artifacts in the images generated** [9948-48]
- 9948 1D **Optical chaos generation and frequency pulling effects through external input signal in nonlinear delayed feedback system using VICSEL** [9948-49]
- 9948 1E **A smart grid technology for electrical power transmission lines by a self-organized optical network using LED** [9948-50]

Authors

Numbers in the index correspond to the last two digits of the six-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first four digits reflect the volume number. Base 36 numbering is employed for the last two digits and indicates the order of articles within the volume. Numbers start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B...0Z, followed by 10-1Z, 20-2Z, etc.

Adams, Daniel, 0U	Grabovickic, D., 0M
Aguilar, D., 0J	Gray, Norman, 08
Akiyama, Akira, 18	Hahlweg, Cornelius, 0X
Arablouei, Reza, 0A	Hariri, Ali, 1C
Aydin, K., 0Q	Hendry, Martin, 08
Bai, Yu, 04	Howell, John C., 0O
Bari, Joseph, 0T	Hsu, Hsin-Yun, 09
Belhaire, E., 0B	Huang, Cheng-Sheng, 09
Benítez, P., 0M	Jackson, Alex, 0E
Bevis, Charles, 0U	Jäger, Kai, 0X
Boucarut, Ray, 0I	Jiang, Yadong, 04
Bourgenot, Cyril, 0N	Kapteyn, Henry, 0U
Brockner, Donovan E., 07	Karl, Robert, 0U
Brown, Mya, 0E	Kim, Yeong-Sik, 11
Bruce, Neil C., 0Z	Kiontke, Sven R., 0L
Buljan, M., 0M	Kodkin, Vladimir L., 14
Cadena, L., 0J	Kraft, Sebastian, 0Y
Çalışkan, Ahmet, 0D	Kumagai, Hideo, 18
Calixto, Sergio, 0Z	Kusy, Branislav, 0A
Callewaert, F., 0Q	Lee, Jin-Ho, 02
Campbell, Sawyer D., 07	Leon, P., 0J
Chalupka, Uwe, 0F	Lépine, T., 0B
Champagnat, F., 0B	Lim, Tae-Yeon, 11
Chang, Seunghyuk, 1B	Lin, Hsin-An, 09
Chang, Shengqian, 03	Liu, Jing, 03
Chen, Anqiu, 03	Liu, Siqi, 03
Chen, Qian, 13	MacSporran, Ross, 08
Choi, Joseph S., 0O	Mancini, Giulia F., 0U
Choi, Kyuhwan, 02	Martin, Bryan, 0I
Choi, Yoonsun, 02	Mendes-Lopes, J., 0M
Chu, Chin-Hsien, 1A	Miñano, Juan C., 0M
Çivitci, Fehmi, 0D	Montes-Perez, Areli, 0Z
Cossu, K., 0B	Morozov, Alexander, 02
Courtial, Johannes, 08, 0N	Mukoda, Yoshiki, 1E
Cowie, Euan N., 08, 0N	Munshi, Zarina, 0E
Druart, G., 0B	Murnane, Margaret, 0U
Easum, John A., 07	Murphy, Megan, 0E
Eichas, Felix, 0W, 0Y	Nagar, Jogender, 07
Espinosa, N., 0J	Nakata, Shun, 1E
Fang, Yi-Chin, 1A	Nam, Dongkyung, 02
Fatima, Afreen, 1C	Narasimhan, B., 0M
Ferhanoğlu, Onur, 0D	Nasiravanaki, Mohammadreza, 1C
Fuchs, Ulrike, 0K, 0L	Nikolic, Milena, 0M
Gao, Hang, 13, 15	O'Donnell, Ruairidh, 08
Gardner, Dennis F., 0U	Osovitsky, A., 0J
Gensemer, Stephen, 0A	Oxburgh, Stephen, 08
Goan, Ethan, 0A	Park, Du-Sik, 02
Gökdel, Yiğit Dağhan, 0D	Park, Sung-Chan, 11
Gore, Richard, 0I	Penn, Jonathan, 0I

Petruck, P., 0K
 Porter, Christina, 0U
 Pradel, Jean S., 0E
 Rachlin, Yaron, 0T
 Ramesh, Manu, 0T
 Ramsey, J. L., 05
 Rawal, Swati, 0P
 Reichenadter, Jonathan, 0U
 Reshidko, Dmitry, 06
 Robertson, David, 0N
 Rosete-Aguilar, Martha, 0Z
 Rothe, Hendrik, 0F
 Sasaki, Wakao, 1D, 1E
 Sasian, Jose, 06
 Savaş, Janset, 0D
 Shah, Vinay, 0T
 Shanblatt, Elisabeth, 0U
 Shepard, R. Hamilton, 0T
 Shih, Tina, 0T
 Shinde, Junichi, 1D
 Singh, Brahm Raj, 0P
 Sinha, R. K., 0P
 Sotomayor, D., 0J
 Sui, Xiubao, 13, 15
 Tanksalvala, Michael, 0U
 Tong, William G., 0E
 Unger, B. L., 05
 Vega, C., 0J
 Vila, J., 0J
 Weiß, Jürgen, 0X
 Werner, Douglas H., 07
 Werner, Pingjuan L., 07
 Weyer, Cornelia, 0X
 Wickenhagen, S., 0K
 Xing, Tingwen, 04
 Yanusik, Igor, 02
 Yen, Chih-Ta, 1A
 Yin, Cong, 0S
 Yuan, Fei, 03
 Zamora, P., 0M
 Zeng, Junjie, 15
 Zhang, Haiyu, 03
 Zhang, Tong, 0S
 Zhao, Yao, 13, 15
 Zhao, Yuejin, 0S
 Zheng, Zhenrong, 03
 Zhou, Shenghang, 13
 Zhu, Linjing, 03
 Zölzer, Udo, 0W, 0Y

Conference Committee

Program Track Chairs

José Sasián, College of Optical Sciences, The University of Arizona
(United States)
R. John Koshel, College of Optical Sciences, The University of Arizona
(United States)

Conference Chairs

Arthur J. Davis, ORAFOL Americas, Inc. (United States)
Cornelius F. Hahlweg, bbw Hochschule (Germany)
Joseph R. Mulley, Melles Griot (United States)

Conference Program Committee

Francois Callewaert, Northwestern University (United States)
Joseph S. Choi, University of Rochester (United States)
Yi Chin Fang, National Kaohsiung First University of Science and
Technology (Taiwan)
Peter I. Goldstein, Philips Color Kinetics (United States)
G. Groot Gregory, Synopsys, Inc. (United States)
Eric Herman, The Aerospace Corporation (United States)
R. John Koshel, College of Optical Sciences, The University of Arizona
(United States)
Scott A. Lerner, Carl Zeiss AG (Germany)
Bharathwaj Appan Narasimhan, CeDInt-UPM (Spain)
Craig Olson, L-3 Communications (United States)
Jeffrey J. Perkins, Q-Peak (United States)
José Sasián, College of Optical Sciences, The University of Arizona
(United States)
David L. Shealy, The University of Alabama at Birmingham
(United States)
R. Hamilton Shepard III, MIT Lincoln Laboratory (United States)
Haiyin Sun, ChemImage Corporation (United States)
Udo Zölzer, Helmut-Schmidt-Universität (Germany) and Universität der
Bundeswehr München (Germany)

Session Chairs

- 1 Displays
Joseph S. Choi, University of Rochester (United States)
- 2 Optimization/Simulation
Eric Herman, The Aerospace Corporation (United States)
- 3 Hyperspectral/UV/IR Systems
R. Hamilton Shepard III, MIT Lincoln Laboratory (United States)
- 4 Instrumentation and Camera Systems
Craig Olson, L-3 Communications (United States)
- 5 Freeform and Unconventional Optics
R. John Koshel, College of Optical Sciences, The University of Arizona (United States)
- 6 Photonics and Lasers
G. Groot Gregory, Synopsys, Inc. (United States)
- 7 Computational Imaging
Udo Zölzer, Helmut-Schmidt-Universität (Germany)
- 8 Optics and Sound
Yi Chin Fang, National Kaohsiung First University of Science and Technology (Taiwan)

Introduction

The nineteenth annual conference for Novel Optical Systems Design and Optimization was held in San Diego, California this year. Our technical sessions included tracks on Displays; Optimization/Simulation; Hyperspectral/UV/IR Systems; Instrumentation and Camera Systems; Freeform and Unconventional Optics; Photonics and Lasers; Computational Imaging; and Optics and Sound. In addition, there was a poster session, a joint *Optical Engineering* Plenary Session and Technical Group Events.

The session on Displays had interesting presentations on futuristic display technologies such as glasses-free 3D displays and transparent glass display panels. Optimization and Simulation included the novel application of the instantaneous Abbe Number for athermalization; optimization of GRINs without raytracing; and the simulation of photography for a camera moving near the speed of light. In Hyperspectral/UV/IR Systems we saw new and interesting approaches to hyperspectral imaging and 3D IR imaging. The Instrumentation and Camera Systems session demonstrated progress toward fully 3D-printed optical instrumentation and contemporary methods for tracking ballistic projectiles. In Freeform and Unconventional Optics, we saw further developments in using freeform surfaces in imaging applications, helmet-mounted displays and visible-spectrum cloaking. We had our first ever presentations in the area of Novel Photonics in our Photonics and Laser session, where a promising technique for optimizing next-generation photonic structures was shown. The Computational Imaging session presented some interesting techniques for increasing the field of view of an IR camera and optics-free diffraction-limited imaging. Finally, the Optics and Sound session included some fascinating light modulation visualizations for sound and an informative look at how optics are used in various audio technologies.

Our conference had two invited papers this year. Our thanks to Uwe Chalupka from Helmut-Schmidt University for his presentation on measuring projectile trajectories. Also thanks to Udo Zölzer for a very nice summary on the state of the art of optical techniques used for sound processing.

We are very grateful to those who helped make this conference a success, especially the authors, audience, SPIE staff, and program committee. The SPIE staff ensured that everything ran smoothly before, during, and after the meeting. The program committee provided excellent assistance to ensure the quality of the content while also presiding over a number of the sessions. Our Session Chairs were Joseph Choi, Yi Chin Fang, G. Groot Gregory, Eric Herman, R. John Koshel, Craig Olson, R. Hamilton Shepard and Udo Zölzer. Thanks to them for keeping our conference running smoothly and on time. Also thanks to everyone else on our Program Committee for helping review the Abstracts and Paper Submissions: Haiyin

Sun, Bharathwaj Narasimhan, David Shealy, Jeffrey Perkins, Peter Goldstein, Jose Sasian and Scott Lerner.

Next year we will return for our twentieth conference. The chairs will be Arthur Davis, Cornelius Hahlweg and Joseph Mulley. We look forward to seeing you in 2017!

Arthur J. Davis
Cornelius F. Hahlweg
Joseph R. Mulley