

PROCEEDINGS OF SPIE

Advances in Display Technologies VII

**Liang-Chy Chien
Tae-Hoon Yoon
Sin-Doo Lee**
Editors

**1–2 February 2017
San Francisco, California, United States**

Sponsored and Published by
SPIE

Volume 10126

Proceedings of SPIE 0277-786X, V. 10126

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

Advances in Display Technologies VII, edited by Liang-Chy Chien, Tae-Hoon Yoon, Sin-Doo Lee,
Proc. of SPIE Vol. 10126, 101260S · © 2017 SPIE · CCC code: 0277-786X/17/\$18 · doi: 10.1117/12.2275401

Proc. of SPIE Vol. 10126 101260S-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 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 *Advances in Display Technologies VII*, edited by Liang-Chy Chien, Tae-Hoon Yoon, Sin-Doo Lee, Proceedings of SPIE Vol. 10126 (SPIE, Bellingham, WA, 2017) Seven-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-786X (electronic)

ISBN: 9781510606937

ISBN: 9781510606944 (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 © 2017, 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/17/\$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**

SPIEDigitalLibrary.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 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

v	<i>Authors</i>
vii	<i>Conference Committee</i>
ix	<i>Introduction</i>

SESSION 1 DISPLAY, IOT, MANUFACTURING, AND COMPONENTS

10126 02	The design considerations for full-color e-paper (Invited Paper) [10126-1]
10126 03	Design of a backlighting structure for very large-area luminaries [10126-2]
10126 04	New generation of Fourier optics viewing angle measurement systems [10126-3]
10126 06	Evaluation of display technologies for Internet of Things (IoT) [10126-5]
10126 07	Dielectric breakdown of fast switching LCD shutters [10126-6]

SESSION 2 3D AND HOLOGRAPHIC DISPLAYS

10126 08	Augmented reality 3D display based on integral imaging (Invited Paper) [10126-7]
10126 09	Temporal accommodation response measured by photorefractive accommodation measurement device [10126-8]
10126 0A	Effect of spatial coherence of LED sources on image resolution in holographic displays [10126-9]
10126 0B	Application of digital optical phase conjugation in the problem of three-dimensional polygonal hologram formation [10126-10]
10126 0C	Viewing angle enhancement of a real-time integral imaging system using multi-directional projections and GPU parallel processing [10126-11]
10126 0E	Augmented reality 3D display using head-mounted projectors and transparent retro-reflective screen [10126-13]

SESSION 3 PROJECTION DISPLAYS AND SPATIAL LIGHT MODULATORS

10126 0I	Design of a 360-degree holographic 3D video display using commonly available display panels and a paraboloid mirror [10126-28]
----------	---

POSTER SESSION

- 10126 0J **Advanced wavefront correction of spatial light modulator under temperature-varying conditions** [10126-17]
- 10126 0M **High-efficiency multiple-light-source red-green-blue power combiner with optical waveguide mode coupling technique** [10126-20]
- 10126 0N **Dual purpose passive screen for simultaneous display and imaging** [10126-21]
- 10126 0O **Aerial secure display by use of polarization-processing display with retarder film and retro-reflector** [10126-23]
- 10126 0P **Hybrid display of static image and aerial image by use of transparent acrylic cubes and retro-reflectors** [10126-24]
- 10126 0Q **Improvement of 3D surface reconstruction using fringe projection by Talbot effect and extended Fourier transform** [10126-25]
- 10126 0R **Design of an ultra-thin near-eye display with geometrical waveguide and freeform optics** [10126-26]

Authors

Numbers in the index correspond to the last two digits of the seven-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first five 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.

Aas, Mehdi, 0A	Randone, E. M., 03
Alam, Md. Ashraf, 0C	Rutkis, Martins, 07
Alam, Md. Shahinur, 0C	Sabo, Julia, 06
Benedetti, M., 03	Sakamoto, J., 0M
Benetti, G., 03	Salgado Verduzco, Marco Antonio, 0Q
Bignon, Thibault, 04	Sekacis, Ilmars, 07
Blankenbach, Karlheinz, 06	Simonetta, M., 03
Boher, Pierre, 04	Song, Byoungsub, 09
Carraro, L., 03	Soomro, Shoaib R., 0E, 0N
Cisowski, Matthäus Stephanus, 06	Subhani, Mahfuze, 0C
Collomb-Patton, Véronique, 04	Suyama, Shiro, 0O
Deng, Huan, 08	Takiguchi, Yu, 0J
Eichberger, Domenik, 06	Tareque, Mohd. Zishan, 0C
Eralp, Muhsin, 0N	Toyoda, Haruyoshi, 0J
Facchinetti, T., 03	Tramonte, A., 03
Fegert, Tobias, 06	Tsai, Meng-Che, 0R
Giuliani, G., 03	Uchida, Keitaro, 0O
González Campos, Rafael, 0Q	Ulusoy, Erdem, 0A, 0N
Hashimoto, T., 0M	Ürey, Hakan, 0A, 0E, 0N
He, Min-Yang, 08	Vovk, Tatiana A., 0B
Ibarra Torres, Juan Carlos, 0Q	Wang, Li, 02
Inoue, Takashi, 0J	Wang, Qiong-Hua, 08
Islam, Md. Sifatul, 0C	Wang, Yu-Cheng, 02
Ito, Shusei, 0O, 0P	Watanabe, K., 0M
Itoh, M., 0M	Yamamoto, Hirotsugu, 0O, 0P
Katayose, S., 0M	Yang, Bo-Ru, 02
Keränen, K., 03	Ylisaukko-Oja, A., 03
Kim, Nam, 0C	Zhang, Han-Le, 08
Lee, Tsung-Xian, 0R	
Leportier, Thibault, 09	
Leroux, Thierry, 04	
Leroux, Vincent, 04	
López Chacón, Jennifer, 0Q	
Marsal, Anatolij, 06	
Mäyrä, A., 03	
Medvids, Arturs, 07	
Mizushina, Haruki, 0O	
Morita, Shogo, 0P	
Mozolevskis, Gatis, 07	
Nitiss, Edgars, 07	
Olivares Pérez, Arturo, 0Q	
Onural, Levent, 0I	
Ortiz Gutiérrez, Mauricio, 0Q	
Otsu-Hyodo, Tomoko, 0J	
Park, Min-Chul, 09	
Pérez Cortés, Mario, 0Q	
Petrov, Nikolay V., 0B	
Pourreza Ghouschi, Vahid, 0A	
Rafi, M. Rashidur Rahman, 0C	

Conference Committee

Symposium Chairs

Jean-Emmanuel Broquin, IMEP-LAHC (France)
Shibin Jiang, AdValue Photonics, Inc. (United States)

Symposium Co-chairs

Connie J. Chang-Hasnain, University of California, Berkeley
(United States)
Graham T. Reed, Optoelectronics Research Centre, University of
Southampton (United Kingdom)

Program Track Chair

Liang-Chy Chien, Kent State University (United States)

Conference Chairs

Liang-Chy Chien, Kent State University (United States)
Tae-Hoon Yoon, Pusan National University (Korea, Republic of)
Sin-Doo Lee, Seoul National University (Korea, Republic of)

Conference Co-chair

Ming Hsien Wu, Hamamatsu Corporation (United States)

Conference Program Committee

Karlheinz Blankenbach, Pforzheim Universität (Germany)
Pierre M. Boher, ELDIM (France)
Cheng-Huan Chen, National Tsing Hua University (Taiwan)
Chin Hsin Chen, National Chiao Tung University (Taiwan)
Janglin Chen, Industrial Technology Research Institute (Taiwan)
Jurgen H. Daniel, PARC, A Xerox Company (United States)
Paul S. Drzaic, Apple Inc. (United States)
Mark Fihn, Veritas et Visus (United States)
Norbert Fruehauf, Universität Stuttgart (Germany)
Nobuyuki Hashimoto, Citizen Holdings Company, Ltd. (Japan)
Klaus Hecker, VDMA (Germany)
Jason C. Heikenfeld, University of Cincinnati (United States)
Alex Henzen, IRX-Innovations B.V. (Netherlands)
Yi-Pai Huang, National Chiao Tung University (Taiwan)
Lachezar Komitov, Universitet of Gothenburg (Sweden)

Byoung-ho Lee, Seoul National University (Korea, Republic of)
Kars-Michiel H. Lenssen, Philips Research Nederland B.V.
(Netherlands)
Akihiro Mochizuki, i-CORE Technology, LLC (United States)
Keith Rollins, DuPont Teijin Films U.K. Ltd. (United Kingdom)
Robert A. Sprague, Amazon Laboratory 126 (United States)
Andrew J. Steckl, University of Cincinnati (United States)
Qiong-Hua Wang, Sichuan University (China)
Michael Wittek, Merck KGaA (Germany)

Session Chairs

- 1 Display, IoT, Manufacturing, and Components
Liang-Chy Chien, Kent State University (United States)
- 2 3D and Holographic Displays
Tae-Hoon Yoon, Pusan National University (Korea, Republic of)
- 3 Projection Displays and Spatial Light Modulators
Akihiro Mochizuki, i-CORE Technology, LLC (United States)

Introduction

Welcome to the proceedings from the conference on Advances in Display Technologies VII (ADT VII), part of Displays and Holography track of the SPIE Photonics West 2017 symposium. The ADT conference was started in 2010, and had evolved from the Projection Display conference chaired by Dr. Ming Hsien Wu of Hamamatsu Photonics Incorporated. The ADT conference is now firmly established as one of the key conferences focusing on liquid crystal manufacturing, display technologies, and applications.

This conference provides a platform for academic and industrial scientists and engineers to present high-impact scientific and technological research on recent advances in display technologies. Numerous emerging topics on display technology have significantly improved the performance of existing devices and created new devices. The topics of ADT-VII included: Display Manufacturing and Components, Internet of Things, 3D Displays, Holographic Displays, Projection Displays and Spatial Light Modulators. The conference featured keynote, invited, topical oral and poster papers.

We hope that you had a stimulating and enjoyable experience at Advances Display Technologies VII!

**Liang-Chy Chien
Tae-Hoon Yoon
Sin-Doo Lee**

