PROCEEDINGS OF SPIE

Optical Technology and Measurement for Industrial Applications 2020

Takeshi Hatsuzawa
Rainer Tutsch
Toru Yoshizawa
Editors

Yokohama, Japan
20–24 April 2020

Sponsored by
The Japan Society for Precision Engineering (JSPE)
SPIE

Published by
SPIE

Volume 11523

Proceedings of SPIE 0277-786X, V. 11523

Optical Technology and Measurement for Industrial Applications 2020, edited by T. Hatsuzawa, R. Tutsch, T. Yoshizawa,
Proc. of SPIE Vol. 11523, 1152301 · © 2020 SPIE · CCC code: 0277-786X/20/$21 · doi: 10.1117/12.2574753

Please use the following format to cite material from these proceedings:
Author(s), "Title of Paper," in *Optical Technology and Measurement for Industrial Applications 2020*, edited by Takeshi Hatsuzawa, Rainer Tutsch, Toru Yoshizawa, Proceedings of SPIE Vol. 11523 (SPIE, Bellingham, WA, 2020) Seven-digit Article CID Number.

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

ISBN: 9781510638532
ISBN: 9781510638549 (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

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
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

POLARIMETRY/ELLIPSOMETRY

NOVEL OPTICAL TESTING

SURFACE INSPECTION METHODS AND APPLICATIONS

APPLICATION OF INTERFEROMETRIC TECHNIQUES

UNIQUE OPTICAL SYSTEMS FOR INSPECTION AND MEASUREMENTS

2D AND 3D MACHINE VISION METHODS AND APPLICATIONS

STRUCTURED LIGHT METHODS, FRINGE PROJECTION MEASUREMENT AND APPLICATIONS

SPHERICAL AND ASPHERICAL MEASUREMENTS

NOVEL INTERFEROMETRY

INVITED SESSION

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.

Conference Committee

Conference Chair

Takeshi Hatsuzawa, Tokyo Institute of Technology (Japan)

Conference Co-Chairs

Rainer Tutsch, Technische Universität Braunschweig (Germany)
Toru Yoshizawa, Tokyo University of Agriculture and Technology (Japan)

Conference Program Committee

Masato Aketagawa, Nagaoka University of Technology (Japan)
Yasuhiko Arai, Kansai University (Japan)
Prathan Buranasiri, King Mongkut's Institute of Technology Ladkrabang (Thailand)
Jürgen W. Czarske, Technische Universität Dresden (Germany)
Motoharu Fujigaki, University of Fukui (Japan)
Amalia Martínez-García, Centro de Investigaciones en Óptica, A.C. (Mexico)
Satoshi Gonda, National Institute of Advanced Industrial Science and Technology (Japan)
Sen Han, University of Shanghai for Science and Technology (China)
Feng-Lei Hong, Yokohama National University (Japan)
Nathan Hagen, Utsunomiya University (Japan)
Hideki Ina, Canon Inc. (Japan)
Ichiro Ishimaru, Kagawa University (Japan)
Lianhua Jin, University of Yamanashi (Japan)
Daesuk Kim, Chonbuk National University (Korea, Republic of)
Jonathan D. Kofman, University of Waterloo (Canada)
Kazuhide Kamiya, Toyama Prefectural University (Japan)
Qian Kemao, Nanyang Technological University (Singapore)
Fumio Koyama, Tokyo Institute of Technology (Japan)
Ryoichi Kuwano, Hiroshima Institute of Technology (Japan)
Yu-Lung Lo, National Cheng Kung University (Taiwan)
Yasuhiro Mizutani, Osaka University (Japan)
Christian Rembe, Technische Universität Clausthal (Germany)
Yukitoshi Otani, Utsunomiya University (Japan)
Pavel Pavlicek, Palacký University Olomouc (Czech Republic)
Takamasa Suzuki, Niigata University (Japan)
Satoru Takahashi, The University of Tokyo (Japan)
Toshiyuki Takatsuji, National Institute of Advanced Industrial Science and Technology (Japan)

Toshitaka Wakayama, Saitama Medical University (Japan)
Wei-Chung Wang, National Tsing Hua University (Taiwan)
Gao Wei, Tohoku University (Japan)
Jiangtao Xi, University of Wollongong (Australia)
Hayato Yoshioka, Tokyo Institute of Technology (Japan)
Song Zhang, Purdue University (United States)

Introduction

The first Optical Technology and Measurement for Industrial Applications Conference (OPTM) was held in Minatomirai, Yokohama JAPAN from 23 to 25 April 2019, as a part of the Optics and Photonics International Congress 2019, sponsored by the SPIE and Mechano-optics technical committee in the Japan Society of Precision Engineering. In the conference, 35 oral presentations and 15 posters were presented, which quite a lot for a first time. The topics are full of variety ranging from profilometry, data acquisition, metrology, inspection etc., showing deep interests in this technical field.

The aim of the OPTM 2020 is to provide an international opportunity for introducing up-to-date technology in the field of optical measurement and their applications for industries while at the same time, providing a networking opportunity for young researchers and students; which is another important role of the conference. Also in the venue, other optics related exhibitions and conferences will be held which is a good chance to foster interest in different technical fields. We hope your visit to the port of Yokohama will represent a new step in your technical and research career.

Takeshi Hatsuzawa
Rainer Tutsch
Toru Yoshizawa