

PROCEEDINGS OF SPIE

MOEMS and Miniaturized Systems XXI

**Hans Zappe
Wibool Piyawattanametha
Yong-Hwa Park**
Editors

**22–27 January 2022
San Francisco, California, United States**

**20–24 February 2022
ONLINE**

Cosponsored by
Mirrorcle Technologies, Inc. (United States)

Published by
SPIE

Volume 12013

Proceedings of SPIE 0277-786X, V. 12013

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 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 *MOEMS and Miniaturized Systems XXI*, edited by Hans Zappe, Wibool Piyawattanametha, Yong-Hwa Park, Proc. of SPIE 12013, Seven-digit Article CID Number (DD/MM/YYYY); (DOI URL).

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510648975

ISBN: 9781510648982 (electronic)

Published by

SPIE

P.O. Box 10, Bellingham, Washington 98227-0010 USA

Telephone +1 360 676 3290 (Pacific Time)

SPIE.org

Copyright © 2022 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.

**SPIE. DIGITAL
LIBRARY**

SPIDigitalLibrary.org

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

v *Conference Committee*

MICRO-CAMERAS

12013 02 **Performance of MOEMS FPI based cubic-inch hyperspectral camera (Invited Paper)** [12013-2]

LIDAR AND 3D IMAGING

12013 03 **Distance measurement error compensation using machine learning for laser scanning AMCW time-of-flight sensor** [12013-6]

12013 04 **Optical MEMS enable next generation solutions for robot vision and human-robot interaction** [12013-7]

MICRO-MIRRORS

12013 05 **Piezoelectric MEMS mirrors for the next generation of small form factor AR glasses (Best Paper Award)** [12013-9]

12013 06 **MEMS piston mirror arrays for computer generated holography (Invited Paper)** [12013-10]

12013 07 **Rapid control prototyping for Al(Sc)N based highly linear quasi-static MEMS mirrors with large optical apertures** [12013-11]

12013 08 **Fully integrated system-in-package device for drive, sense, and control of MEMS μ mirrors for Raster scan projection** [12013-12]

12013 09 **Piezoelectric MEMS mirror optimized by particle swarm optimization algorithm** [12013-13]

12013 0A **Optimized actuation of resonant MEMS mirrors for laser beam scanning applications** [12013-14]

SCANNERS

12013 0B **High bandwidth back-scanning mirror for coherent chirped pulse lidar imaging** [12013-16]

12013 0C **Micromachined water-immersible scanning mirror with torsional and bending hinges** [12013-17]

12013 OD **A 3D scanner: low footprint piezoelectric tunable optical scanner
(Invited Paper Best Student Paper Award)** [12013-15]

SPECTROMETERS

12013 OE **Miniature NIR spectrometer for mobile applications** [12013-19]

MICRO-OPTICAL COMPONENTS

12013 OF **3D printing optical components for microscopy using a desktop 3D printer** [12013-22]

POSTER SESSION

12013 OG **Enhanced travel range bipolar tri-electrode electrostatic actuator using extended background electrode** [12013-25]

12013 OH **Lab-on-chip module for fluorescence detection** [12013-26]

12013 OI **Removal of systematic distance error due to correlated stray light in laser scanning-based AMCW time-of-flight sensor** [12013-27]

12013 OJ **Modeling and experimental validation of hysteretic scan behavior of quasi-static piezoelectric micromirror** [12013-28]

12013 OK **Tri-axial optical MEMS accelerometer enables monolithic fabrication** [12013-30]