

PROCEEDINGS OF SPIE

# ***MOEMS and Miniaturized Systems XIX***

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

**1–3 February 2020**  
**San Francisco, California, United States**

*Sponsored by*  
SPIE

*Cosponsored by*  
Mirrorcle Technologies, Inc. (United States)

*Published by*  
SPIE

**Volume 11293**

Proceedings of SPIE 0277-786X, V. 11293

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](http://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 XIX*, edited by Wibool Piyawattanametha, Yong-Hwa Park, Hans Zappe, Proceedings of SPIE Vol. 11293 (SPIE, Bellingham, WA, 2020) Seven-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510633490

ISBN: 9781510633506 (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](http://SPIE.org)

Copyright © 2020, 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 \$21.00 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](http://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/20/\$21.00.

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](http://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 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 *Authors*  
vii *Conference Committee*

---

## MICRO-MIRRORS

---

- 11293 02 **Novel CMOS-integrated 512x320 tip-tilt micro mirror array and related technology platform (Invited Paper)** [11293-1]
- 11293 03 **Design framework for high-speed 3D scanning tools and development of an axial focusing micromirror-based array** [11293-2]
- 11293 04 **A triple-wafer-bonded AlScN driven quasi-static MEMS mirror with high linearity and large tilt angles** [11293-3]
- 11293 05 **A bi-axial vacuum-packaged piezoelectric MEMS mirror for smart headlights** [11293-4]

---

## LIDAR

---

- 11293 08 **Vibration analysis of micro mirrors for LIDAR using on-chip piezo-resistive sensor (Invited Paper)** [11293-7]
- 11293 09 **Resonant 1D MEMS mirror with a total optical scan angle of 180° for automotive LIDAR** [11293-8]
- 11293 0B **Comparison of MEMS mirror LiDAR architectures** [11293-31]

---

## NOVEL OPTICAL DEVICES I

---

- 11293 0C **Wide and fast mode-hop free MEMS tunable ECDL concept and realization in the NIR and MIR spectral regime (Best Paper Award, Invited Paper)** [11293-10]
- 11293 0D **Minimization of nonlinearities in nano electrostatic drive actuators using validated coupled-field simulation** [11293-11]
- 11293 0F **Dynamic pattern generation by singlemode fibers for endoscopic 3D measurement systems** [11293-13]

---

## NOVEL OPTICAL DEVICES II

---

- 11293 OG **Foveated display by laser scanning** [11293-14]
- 11293 OK **Combined MEMS spectrometer based on Michelson interferometer and tunable filter for wideband selective operation** [11293-19]

---

## IMAGING

---

- 11293 OM **Light-sheet microscopy using MEMS and active optics for 3D image acquisition control (Best Student Paper Award, Invited Paper)** [11293-21]
- 11293 OO **Single-pixel hyperspectral imaging using Hadamard transformation** [11293-23]

---

## ENDOSCOPIC MICROSCOPY: JOINT SESSION WITH 11214 AND 11293

---

- 11293 OR **A 3D actuator for laser scanning endoscopy** [11293-26]

---

## POSTER SESSION

---

- 11293 OS **Effects of optically absorbent coatings on parallel optical control of levitating milli-robots** [11293-17]
- 11293 OT **Compressive sensing MEMS FTIR spectrometer** [11293-27]
- 11293 OU **Multi-walled carbon nanotubes based near-infrared radiation source** [11293-28]
- 11293 OV **Modeling and characterization of the reflectance of vertical metal-coated micromirrors in deeply-etched optical benches** [11293-29]
- 11293 OW **Attenuated total reflection (ATR) MEMS FTIR spectrometer** [11293-30]
- 11293 OX **Coupled MOEMS membranes for enhanced sensing purposes** [11293-32]
- 11293 OY **Molybdenum silicide in infrared emitting devices** [11293-33]
- 11293 OZ **System integration of hybrid large aperture micro scanner array for fast scanning LiDAR sensors** [11293-34]