

PROCEEDINGS OF SPIE

Laser Radar Technology and Applications XXI

Monte D. Turner
Gary W. Kamerman
Editors

19–20 April 2016
Baltimore, Maryland, United States

Sponsored and Published by
SPIE

Volume 9832

Proceedings of SPIE 0277-786X, V. 9832

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 *Laser Radar Technology and Applications XXI*, edited by Monte D. Turner, Gary W. Kameron, Proceedings of SPIE Vol. 9832 (SPIE, Bellingham, WA, 2016) Six-digit Article CID Number.

ISSN: 0277-786X
ISSN: 1996-756X (electronic)
ISBN: 9781510600737

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 *Authors*
ix *Conference Committee*

SESSION 1 INVITED SESSION

9832 02 **A comparison flash lidar detector options (Invited Paper)** [9832-1]

SESSION 2 SINGLE PHOTON SENSITIVE SYSTEMS

9832 03 **Design of the processing chain for a high-altitude, airborne, single-photon lidar mapping instrument** [9832-2]

9832 04 **Linear LIDAR versus Geiger-mode LIDAR: impact on data properties and data quality** [9832-3]

9832 05 **Comparison of simulated and experimental 3D laser images using a GmAPD array: application to long range detection** [9832-4]

9832 07 **Laser production for NASA's Global Ecosystem Dynamics Investigation (GEDI) lidar** [9832-39]

SESSION 3 SPACE APPLICATIONS

9832 08 **Simulation of a Doppler lidar system for autonomous navigation and hazard avoidance during planetary landing** [9832-6]

9832 09 **3D flash lidar performance in flight testing on the Morpheus autonomous, rocket-propelled lander to a lunar-like hazard field** [9832-7]

SESSION 4 DATA PROCESSING AND ALGORITHMS I

9832 0C **Remote sensing-based detection and quantification of roadway debris following natural disasters** [9832-10]

9832 0D **An automated method for registering lidar data in restrictive, tunnel-like environments** [9832-11]

9832 0E **Laser range profiling for small target recognition** [9832-12]

9832 0F **Automated feature extraction for 3-dimensional point clouds** [9832-13]

SESSION 5 DATA PROCESSING AND ALGORITHMS II

- 9832 0G **Generating passive NIR images from active LIDAR** [9832-14]
- 9832 0H **Real-time, mixed-mode computing architecture for waveform-resolved lidar systems with total propagated uncertainty** [9832-15]
- 9832 0J **Research on the method of extracting DEM based on GBInSAR** [9832-17]

SESSION 6 ADVANCED COMPONENT TECHNOLOGY AND SYSTEMS

- 9832 0K **A lightweight, rugged, solid state laser radar system enabled by non-mechanical electro-optic beam steerers** [9832-18]
- 9832 0L **Progress on MEMS-scanned lidar** [9832-19]
- 9832 0M **UAV-borne lidar with MEMS mirror-based scanning capability** [9832-20]
- 9832 0P **Pulse laser imaging amplifier for advanced lidar systems** [9832-23]

SESSION 7 3D IMAGING AND RANGE FINDING

- 9832 0R **Novel, ultra-compact, high-performance, eye-safe laser rangefinder for demanding applications** [9832-24]
- 9832 0S **Three-dimensional image reconstruction using bundle adjustment applied to multiple texel images** [9832-25]
- 9832 0T **Simulated full-waveform lidar compared to Riegl VZ-400 terrestrial laser scans** [9832-26]
- 9832 0V **Application and capabilities of lidar from small UAV** [9832-28]

SESSION 8 SPECTRAL APPLICATIONS I

- 9832 0W **Integrated analysis of light detection and ranging (LiDAR) and hyperspectral imagery (HSI) data** [9832-29]
- 9832 0X **Application of image classification techniques to multispectral lidar point cloud data** [9832-30]
- 9832 0Y **Field-widened Michelson interferometer system as the spectroscopic filter of high-spectral-resolution lidar** [9832-31]
- 9832 0Z **Polarized high-spectral-resolution lidar based on field-widened Michelson interferometer** [9832-32]

SESSION 9 SPECTRAL APPLICATIONS II

- 9832 10 **Atmospheric absorption versus deep ultraviolet (pre-)resonance in Raman lidar measurements [9832-33]**
- 9832 11 **Broadband on-chip mid-IR supercontinuum generation [9832-34]**
- 9832 13 **Comprehensive view of high-spectral-resolution lidar technique from the perspective of spectral discrimination [9832-36]**
- 9832 14 **High-spectral-resolution lidar for ocean ecosystem studies [9832-37]**