Laser Radar Technology and Applications XVIII

Monte D. Turner
Gary W. Kamerman
Editors

30 April–2 May 2013
Baltimore, Maryland, United States

Sponsored and Published by
SPIE

Volume 8731
The papers included 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. The papers published in these proceedings 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 this book:


ISSN: 0277-786X
ISBN: 9780819495228

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 © 2013, 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/13/$18.00.

Printed in the United States of America.

Publication of record for individual papers is online in the SPIE Digital Library.

SPIEDigitalLibrary.org

**Paper Numbering:** Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent citation identifier [CID] number is assigned to each article at the time of the first 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, print, and electronic versions of the publication. SPIE uses a six-digit CID article numbering system in which:

- 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. The complete citation is used on the first page, and an abbreviated version on subsequent pages. Numbers in the index correspond to the last two digits of the six-digit CID Number.
## Contents

**SESSION 1** 3D LIDAR PROCESSING AND EXPLOITATION I

<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Title</th>
<th>Authors and Affiliations</th>
</tr>
</thead>
<tbody>
<tr>
<td>8731 02</td>
<td>Extraction and classification of vehicles in LADAR imagery</td>
<td>H. C. Palm, T. V. Haavardsholm, H. Ajer, C. V. Jensen, Norwegian Defence Research Establishment (Norway)</td>
</tr>
<tr>
<td>8731 03</td>
<td>Methods for LiDAR point cloud classification using local neighborhood statistics</td>
<td>A. M. Kim, R. C. Olsen, F. A. Kruse, Naval Postgraduate School (United States)</td>
</tr>
<tr>
<td>8731 04</td>
<td>Enhancing online waveform processing by adding new point attributes</td>
<td>M. Pfennigbauer, C. Wolf, A. Ullrich, RIEGL Laser Measurement Systems GmbH (Austria)</td>
</tr>
<tr>
<td>8731 05</td>
<td>Classification and extraction of trees and buildings from urban scenes using discrete return LiDAR and aerial color imagery</td>
<td>M. Bandyopadhyay, J. A. N. van Aardt, K. Cawse-Nicholson, Rochester Institute of Technology (United States)</td>
</tr>
<tr>
<td>8731 06</td>
<td>Reconstruction of 3D tree stem models from low-cost terrestrial laser scanner data</td>
<td>D. Kelbe, P. Romanczyk, J. van Aardt, K. Cawse-Nicholson, Rochester Institute of Technology (United States)</td>
</tr>
</tbody>
</table>

**SESSION 2** 3D LIDAR PROCESSING AND EXPLOITATION II

<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Title</th>
<th>Authors and Affiliations</th>
</tr>
</thead>
<tbody>
<tr>
<td>8731 07</td>
<td>Automatic registration of multiple texel images (fused lidar/digital imagery) for 3D image creation</td>
<td>S. E. Budge, N. Badamikar, Utah State Univ. (United States)</td>
</tr>
<tr>
<td>8731 08</td>
<td>3D graph segmentation for target detection in FOPEN LiDAR data</td>
<td>N. Shorter, J. Locke, O. Smith, E. Keating, P. Smith, Harris Corp. (United States)</td>
</tr>
<tr>
<td>8731 09</td>
<td>Fusing LiDAR-based voxel geometry with multi-angle visible imagery</td>
<td>S. Hagström, D. Messinger, Rochester Institute of Technology (United States)</td>
</tr>
<tr>
<td>8731 0A</td>
<td>Point Spread Function (PSF) noise filter strategy for geiger mode LiDAR</td>
<td>O. Smith, R. Stark, P. Smith, R. St. Romain, S. Blask, Harris Corp. (United States)</td>
</tr>
</tbody>
</table>

**SESSION 3** 3D LIDAR PROCESSING AND EXPLOITATION III

<table>
<thead>
<tr>
<th>Paper No.</th>
<th>Title</th>
<th>Authors and Affiliations</th>
</tr>
</thead>
<tbody>
<tr>
<td>8731 08</td>
<td>LiDAR data processing for scalable compression</td>
<td>R. D. Nieves, Exelis Inc. (United States)</td>
</tr>
</tbody>
</table>
Foliage penetration optimization for Geiger-mode avalanche photodiode lidar [8731-12]  
S. E. Johnson, OGSystems (United States)

A comparison of two embedded programming techniques for high rep rate coherent Doppler lidars [8731-14]  
M. F. Arend, S. Abdelazim, M. Lopez, F. Moshary, City College of New York (United States)

Adapting a ground-based laser ranging system at NASA-GSFC for identification and tracking of orbital debris [8731-15]  
D. B. Coyle, P. R. Stysley, J. F. McGarry, S. M. Hull, K. M. Getzandanner, R. P. Young, NASA Goddard Space Flight Ctr. (United States)

Doppler lidar sensor for precision navigation in GPS-deprived environment [8731-16]  
F. Amzajerdian, NASA Langley Research Ctr. (United States); D. F. Pierrottet, Coherent Applications Inc. (United States); G. D. Hines, L. B. Petway, B. W. Barnes, NASA Langley Research Ctr. (United States)

Helicopter flight test of 3D imaging flash LIDAR technology for safe, autonomous, and precise planetary landing [8731-17]  
V. Roback, NASA Langley Research Ctr. (United States); A. Bulyshev, Analytical Mechanics Associates, Inc. (United States); F. Amzajerdian, R. Reisse, NASA Langley Research Ctr. (United States)

A new method to retrieve aerosol extinction coefficients from elastic-Raman lidar data [8731-19]  
J. Su, M. P. McCormick, L. Lei, Hampton Univ. (United States)

Airborne wind profiling algorithms for the pulsed 2-micron coherent doppler Lidar at NASA Langley Research Center [8731-20]  
J. Y. Beyon, G. J. Koch, M. J. Kavaya, NASA Langley Research Ctr. (United States); T. J. Ray, Colorado School of Mines (United States)

Semi-empirical validation of the cross-band relative absorption technique for the measurement of molecular mixing ratios [8731-21]  
D. Pliutau, N. S. Prasad, NASA Langley Research Ctr. (United States)

Understanding lidar returns from complex dust mixtures [8731-22]  

Optical extinction dependence on wavelength and size distribution of airborne dust [8731-23]  
Using a laser aureole to study aerosols [8731-24]

Multistatic lidar measurements of non-spherical aerosols [8731-25]

SESSION 6  TOPOGRAPHIC MAPPING

Difference modeling enhancement of topographic super-resolution [8731-27]
J. Straub, Univ. of North Dakota (United States)

A study on the calibration of pitch-angle deviation for airborne lidar system [8731-28]
L. Jiang, X. Hao, W. Zhang, Zhengzhou Institute of Surveying and Mapping (China)

SESSION 7  MODELING AND SIMULATION

Simulating the performance of laser imaging and range profiling of small surface vessels [8731-31]
O. Steinvall, T. Chevalier, C. Grönwall, Swedish Defense Research Agency (Sweden)

Scintillation effects on round-trip lidar imaging through turbulence with finite-sized objects and collecting apertures: modeling advances [8731-32]
D. G. Youmans, Parsons Corp. (United States)

Comparison of LIDAR system performance for alternative single-mode receiver architectures: modeling and experimental validation [8731-48]
P. Toliver, I. Ozdur, A. Agarwal, T. K. Woodward, Applied Communication Sciences (United States)

SESSION 8  ADVANCE COMPONENTS AND SYSTEMS

Large format geiger-mode avalanche photodiode LADAR camera [8731-33]
P. Yuan, R. Sudharsanan, X. Bai, E. Labios, Spectrolab Inc. (United States); B. Morris, J. P. Nicholson, G. M. Stuart, H. Danny, Boeing DES (United States)

Highly sensitive LIDAR with a thumb-sized sensor-head built using an optical fiber preamplifier (3) [8731-34]
D. Inoue, T. Ichikawa, H. Matsubara, M. Kagami, Toyota Central R&D Labs., Inc. (Japan)

Ice sheet surface elevation retrieval from CALIPSO lidar measurements [8731-40]
X. Lu, Y. Hu, NASA Langley Research Ctr. (United States)

Military forensic use of handheld 3D camera [8731-37]
H. Larsson, D. Letalick, Swedish Defence Research Agency (Sweden)
Planetary boundary layer detection with fractal dimension of three-wavelength lidar signals [8731-39]

L. Lei, Hampton Univ. (United States) and Hefei Univ. of Technology (China);
M. P. McCormick, J. Su, Hampton Univ. (United States)
Conference Committee

Symposium Chair

Kenneth R. Israel, Major General (USAF Retired) (United States)

Symposium Cochair

David A. Whelan, Boeing Defense, Space, and Security (United States)

Conference Chairs

Monte D. Turner, Air Force Research Laboratory (United States)
Gary W. Kamerman, FastMetrix, Inc. (United States)

Conference Program Committee

Philip Gatt, Lockheed Martin Coherent Technologies (United States)
Richard M. Heinrichs, Defense Advanced Research Projects Agency (United States)
Robert T. Hintz, Naval Air Warfare Center Weapons Division (United States)
Norman A. Lopez, FastMetrix, Inc. (United States)
Vasyl Molebny, National Taras Shevchenko University of Kyiv (Ukraine)
Russell Philbrick, North Carolina State University (United States)
Upendra N. Singh, NASA Langley Research Center (United States)
Ove K. Steinvall, Swedish Defence Research Agency (Sweden)
Douglas G. Youmans, SPARTA Inc./Parsons Corporation (United States)

Session Chairs

1 3D LIDAR Processing and Exploitation I
   Douglas G. Youmans, SPARTA Inc./Parsons Corporation (United States)

2 3D LIDAR Processing and Exploitation II
   Gary W. Kamerman, FastMetrix, Inc. (United States)

3 3D LIDAR Processing and Exploitation III
   Russell Philbrick, North Carolina State University (United States)

4 Space Applications
   Russell Philbrick, North Carolina State University (United States)
5 Atmospheric Sensing
   Ove K. Steinvall, Swedish Defence Research Agency (Sweden)
   Douglas G. Youmans, SPARTA, Inc. (United States)

6 Topographic Mapping
   Pradip Mitra, DRS Technologies, Inc. (United States)

7 Modeling and Simulation
   Gary W. Kamerman, FastMetrix, Inc. (United States)

8 Advance Components and Systems
   Gary W. Kamerman, FastMetrix, Inc. (United States)
   Monte D. Turner, Air Force Research Laboratory (United States)