PROCEEDINGS OF SPIE

Infrared Imaging Systems: Design, Analysis, Modeling, and Testing XXI

Gerald C. Holst Keith A. Krapels Editors

6–8 April 2010 Orlando, Florida, United States

Sponsored and Published by SPIE

Volume 7662

Proceedings of SPIE, 0277-786X, v. 7662

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

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:

Author(s), "Title of Paper," in Infrared Imaging Systems: Design, Analysis, Modeling, and Testing XXI, edited by Gerald C. Holst, Keith A. Krapels, Proceedings of SPIE Vol. 7662 (SPIE, Bellingham, WA, 2010) Article CID Number.

ISSN 0277-786X ISBN 9780819481269

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 © 2010, 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/10/\$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 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

vii Conference Committee

SESSION 1 MODELING NON-THERMAL IMAGING SYSTEMS I

7662 03 NIR small arms muzzle flash [7662-02]

- J. Montoya, S. Kennerly, E. Rede, U.S. Army Research Lab. (United States)
- 7662 04 Experimental determination of visibility modeling parameters for aircraft [7662-04]
 E. J. Boettcher, DCS Corp. (United States); T. Maurer, U.S. Army Night Vision & Electronic Sensors Directorate (United States); S. R. Murrill, U.S. Army Research Lab. (United States);
 B. Miller, U.S. Army Night Vision & Electronic Sensors Directorate (United States)

SESSION 2 MODELING NON-THERMAL IMAGING SYSTEMS II

- 7662 05 **Design and evaluation of (urban) camouflage** [7662-05] M. A. Hogervorst, A. Toet, P. Jacobs, TNO Defence, Security and Safety (Netherlands)
- 7662 06 Comparison of speckle reduction techniques on the identification of human activities in laser range-gated SWIR imaging [7662-06]
 D. Oxford, Defence Science and Technology Lab. (United Kingdom); R. L. Espinola, U.S. Army Night Vision & Electronic Sensors Directorate (United States)
- 7662 07 Performance evaluation of image enhancement techniques on night vision imagery [7662-07]
 J. Dijk, P. Bijl, A. W. M. van Eekeren, TNO Defence, Security and Safety (Netherlands)

SESSION 3 MODELING THERMAL IMAGING SYSTEMS I

7662 09 Flat panel displays for military imaging applications (Invited Paper) [7662-09] S. P. Atwood, L. Collier, Azonix Corp. (United States)

7662 0A Comparing masked target transform volume (MTTV) clutter metric to human observer evaluation of visual clutter [7662-10]
 H. A. Camp, EOIR Technologies, Inc. (United States); S. Moyer, U.S. Army U.S. Army Night Vision & Electronic Sensors Directorate (United States); R. K. Moore, U.S. Army ATEC DTC (United States)

7662 OB Analytical models quantify military benefit of collaborative search [7662-11]
 M. H. Friedman, T. W. Du Bosq, E. A. Flug, U.S. Army Night Vision & Electronic Sensors Directorate (United States)

7662 0C Triangle search experiment to isolate scene clutter effects [7662-12] R. K. Moore, U.S. ATEC DTC (United States); H. A. Camp, EOIR Technologies, Inc. (United States); S. Moyer, U.S. Army U.S. Army Night Vision & Electronic Sensors Directorate (United States); C. E. Halford, Univ. of Memphis (United States)

SESSION 4 MODELING THERMAL IMAGING SYSTEMS II

- 7662 0D Modeling performance using sensor simulation and image metrics [7662-13]
 J. D. Fanning, J. P. Reynolds, U.S. Army Night Vision & Electronic Sensors Directorate (United States)
- 7662 OE Effectiveness assessment of signal processing in the presence of smear [7662-14] P. Bijl, J. A. Beintema, J. Dijk, N. van der Leden, TNO Defence, Security and Safety (Netherlands)
- 7662 OF **Next generation imager performance model** [7662-15] B. Teaney, J. Reynolds, U.S. Army Night Vision & Electronic Sensors Directorate (United States)
- 7662 OG **Readout IC requirement trends based on a simplified parametric seeker model** [7662-16] T. D. Osborn, Sandia National Labs. (United States)

SESSION 5 MODELING THERMAL IMAGING SYSTEMS III

- Adaptive design of visual perception experiments [7662-17]
 J. D. O'Connor, J. Hixson, U.S. Army Night Vision & Electronic Sensors Directorate (United States); J. M. Thomas, Jr., E-OIR Technologies, Inc. (United States); M. S. Peterson, R. Parasuraman, George Mason Univ. (United States)
- New target acquisition task for contemporary operating environments: personnel in MWIR, LWIR, and SWIR [7662-18]
 E. J. Boettcher, DCS Corp. (United States); K. Leonard, V. A. Hodgkin, J. Hixson, B. Miller, S. Johnson, R. Thompson, T. Godbolt, U.S. Army U.S. Army Night Vision & Electronic Sensors Directorate (United States); D. Acton, Raytheon Vision Systems (United States)
- 7662 0J Image fusion algorithm assessment using measures of complementary and redundant information [7662-19]
 C. Howell, U.S. Army U.S. Army Night Vision & Electronic Sensors Directorate (United States) and Univ. of Memphis (United States); C. Halford, Univ. of Memphis (United States);
 K. Krapels, U.S. Army U.S. Army Night Vision & Electronic Sensors Directorate (United States)
- 7662 OK **Multivariate perception testing for fire service thermal imager evaluations** [7662-20] F. Amon, National Institute of Standards and Technology (United States); D. Leber, J. Rowe, Hughes Associates, Inc. (United States)

SESSION 6 MODELING THERMAL IMAGING SYSTEMS IV

7662 OL Resampling analysis of participant variance to improve the efficiency of sensor modeling perception experiments [7662-21]

J. D. O'Connor, J. Hixson, U.S. Army Night Vision & Electronic Sensors Directorate (United States); P. McKnight, M. S. Peterson, R. Parasuraman, George Mason Univ. (United States)

- 7662 0M Masked target transform volume clutter metric applied to vehicle search [7662-22]
 R. K. Moore, U.S. ATEC DTC (United States); H. A. Camp, EOIR Technologies, Inc. (United States); S. Moyer, U.S. Army Night Vision & Electronic Sensors Directorate (United States); C. E. Halford, Univ. of Memphis (United States)
- 7662 ON Improved target signature definition for modeling performance of high-gain saturated imagery [7662-23]
 T. Du Bosq, U.S. Army U.S. Army Night Vision & Electronic Sensors Directorate (United States);
 B. Preece, EOIR Technologies, Inc. (United States)
- 7662 00 **Resolution and sensitivity: simplified imager performance by MTF and PTC** [7662-24] J. A. Mazzetta, S. D. Scopatz, Electro Optical Industries (United States)
- 7662 OP **Clutter effects on airborne tracking resolution requirements for urban vehicles** [7662-25] A. L. Robinson, The Univ. of Memphis (United States); B. Miller, P. Richardson, C. Ra, U.S. Army Night Vision & Electronic Sensors Directorate (United States)

SESSION 7 TARGETS, BACKGROUNDS, AND ATMOSPHERICS

- 7662 0Q **Evaluation tools for the effectiveness of infrared countermeasures and signature reduction for ships** [7662-26] R. Schoemaker, R. Schleijpen, TNO Defence, Security and Safety (Netherlands)
- 7662 OR **CART IV: improving automatic camouflage assessment with assistance methods** [7662-27] T. Müller, M. Müller, Fraunhofer Institute IOSB (Germany)
- The use of SE-WORKBENCH for aircraft infrared signature, taken into account body, engine, and plume contributions [7662-30]
 T. Cathala, N. Douchin, A. Joly, OKTAL Synthetic Environment (France); S. Perzon, Go Virtual AB (Sweden)
- 7662 0V IR susceptibility of naval ships using ShipIR/NTCS [7662-31] D. A. Vaitekunas, W. R. Davis Engineering, Ltd. (Canada)
- 7662 0W Novel methodologies for the measurement of atmospheric turbulence effects [7662-32]
 R. L. Espinola, J. Cha, K. Leonard, U.S. Army Night Vision & Electronic Sensors Directorate (United States)

SESSION 8 SYSTEMS AND TESTING

- 7662 0X Evaluation of a method to radiometric calibrate hot target image data by using simple reference sources close to ambient temperatures [7662-33]
 T. Svensson, I. Renhorn, Swedish Defence Research Agency (Sweden); P. Broberg, Univ. West (Sweden)
- Field calibration of reflective imagery of targets and backgrounds [7662-34]
 V. A. Hodgkin, U.S. Army Night Vision & Electronic Sensors Directorate (United States);
 E. J. Boettcher, DCS Corp. (United States); D. D. Acton, Raytheon Vision Systems (United States)
- 7662 10 Display noise effects on infrared system target acquisition performance [7662-36]
 S. D. Burks, B. P. Teaney, U.S. Army Night Vision & Electronic Sensors Directorate (United States)
- Pixel-wise real-time advanced calibration method for thermal infrared cameras [7662-38]
 P. Tremblay, Univ. Laval (Canada); L. Belhumeur, M. Chamberland, A. Villemaire, P. Dubois,
 F. Marcotte, C. Belzile, V. Farley, P. Lagueux, Telops Inc. (Canada)
- Fast and precise point spread function measurements of IR optics at extreme temperatures based on reversed imaging conditions [7662-39]
 V. Melzer, H.-G. Heckmann, C. Ritter, LINOS Photonics GmbH & Co. KG (Germany); J. Barenz, M. Raab, Diehl BGT Defence GmbH & Co. KG (Germany)
- Non-optically combined multispectral source for IR, visible, and laser testing [7662-46]
 J. LaVeigne, B. Rich, S. McHugh, Santa Barbara Infrared, Inc. (United States); P. Chua, Diverse Fabrications (United States)

POSTERS SESSION

- Review of Bayer pattern CFA demosaicing with new quality assessment algorithms [7662-40]
 R. A. Maschal, Jr., S. S. Young, U.S. Army Research Lab. (United States); J. Reynolds,
 K. Krapels, J. Fanning, T. Corbin, U.S. Army Night Vision & Electronic Sensors Directorate (United States)
- 7662 16 D8: an image capturing software for advanced applications including temporal synchronization of imaging sensors [7662-42]
 S. Cronström, T. Svensson, I. Renhorn, Swedish Defence Research Agency (Sweden)
- 7662 17 Performance evaluation of FIR sensor systems applied to pedestrian detection [7662-43]
 S. Franz, R. Schweiger, O. Loehlein, Daimler AG (Germany); D. Willersinn, K. Kroschel, Fraunhofer IOSB (Germany)
- 7662 18 Estimation of radiant intensity and average emissivity of Magnesium/Teflon/Viton (MTV) flares [7662-44]

L. B. Magalhães, F. D. P. Alves, Instituto Tecnológico de Aeronáutica (Brazil)

Author Index

Conference Committee

Symposium Chair

Michael T. Eismann, Air Force Research Laboratory (United States)

Symposium Cochair

William Jeffrey, HRL Laboratories, LLC (United States)

Conference Chairs

Gerald C. Holst, JCD Publishing (United States) Keith A. Krapels, U.S. Army Night Vision & Electronic Sensors Directorate (United States)

Program Committee

Piet Bijl, TNO Human Factors (Netherlands) Ronald G. Driggers, U.S. Naval Research Laboratory (United States) Richard L. Espinola, U.S. Army Night Vision & Electronic Sensors Directorate (United States) David P. Forrai, L-3 Communications Cincinnati Electronics (United States) Alan Irwin, Santa Barbara Infrared, Inc. (United States) Terrence S. Lomheim, The Aerospace Corporation (United States) Luanne P. Obert, U.S. Army Night Vision & Electronic Sensors Directorate (United States) Endre Repasi, FGAN-FOM (Germany) Hector Reyes, Raytheon Company (United States) Joseph P. Reynolds, U.S. Army Night Vision & Electronic Sensors Directorate (United States) Bernard M. Rosier, ONERA (France) Ronald B. Sartain, U.S. Army Research Laboratory (United States) Michael A. Soel, FLIR Systems, Inc. (United States) Curtis M. Webb, Northrop Grumman Electronic Systems (United States)

Session Chairs

 Modeling Non-thermal Imaging Systems I Terrence S. Lomheim, The Aerospace Corporation (United States) Michael A. Soel, FLIR Systems, Inc. (United States)

- Modeling Non-thermal Imaging Systems II
 David P. Forrai, L-3 Communications Cincinnati Electronics (United States)
 Michael A. Soel, FLIR Systems, Inc. (United States)
- Modeling Thermal Imaging Systems I
 Keith A. Krapels, U.S. Army Night Vision & Electronic Sensors Directorate (United States)
 Hector Reyes, Raytheon Company (United States)
 Ronald B. Sartain, U.S. Army Research Laboratory (United States)
- Modeling Thermal Imaging Systems II
 Ronald G. Driggers, U.S. Naval Research Laboratory (United States)
 Terrence S. Lomheim, The Aerospace Corporation (United States)
- Modeling Thermal Imaging Systems III
 Ronald G. Driggers, U.S. Naval Research Laboratory (United States)
 David P. Forrai, L-3 Communications Cincinnati Electronics (United States)
- Modeling Thermal Imaging Systems IV
 Keith A. Krapels, U.S. Army Night Vision & Electronic Sensors Directorate (United States)
 Michael A. Soel, FLIR Systems, Inc. (United States)
 Ronald B. Sartain, U.S. Army Research Laboratory (United States)
- 7 Targets, Backgrounds, and Atmospherics
 Richard L. Espinola, U.S. Army Night Vision & Electronic Sensors Directorate (United States)
 Endre Repasi, FGAN-FOM (Germany)
 Bernard M. Rosier, ONERA (France)
- 8 Systems and Testing
 Alan Irwin, Santa Barbara Infrared, Inc. (United States)
 Curtis M. Webb, Northrop Grumman Electronic Systems (United States)