

PROCEEDINGS OF SPIE

Electro-Optical and Infrared Systems: Technology and Applications XXI

Duncan L. Hickman
Helge Bürsing
Ove Steinvall
Philip J. Soan
Editors

16–19 September 2024
Edinburgh, United Kingdom

Sponsored by
SPIE

Event Sponsor
Leonardo MW Ltd. (United Kingdom)

General Sponsors
HGH Infrared Systems (France) • Photon Lines Ltd. (United Kingdom) • Pro-Lite Technology Ltd. (United Kingdom) •
Thales (United Kingdom)

Cooperating Organisations
Cranfield University (United Kingdom) • Quantum Security and Defense Working Group (United Kingdom) • CENSIS
(United Kingdom) • Innovate UK (United Kingdom) • Optoelectronics Research Centre (United Kingdom) • Photonics21
(Germany) • Technology Scotland (United Kingdom) • Science and Technology Facilities Council (United Kingdom) •
UKQuantum (United Kingdom) • Visit Britain (United Kingdom)

Published by
SPIE

Volume 13200

Proceedings of SPIE 0277-786X, V. 13200

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

Electro-Optical and Infrared Systems: Technology and Applications XXI, edited by
Duncan L. Hickman, Helge Bürsing, Ove Steinvall, Philip J. Soan, Proc. of SPIE
Vol. 13200, 1320001 • © 2024 SPIE • 0277-786X • doi: 10.1117/12.3054794

Proc. of SPIE Vol. 13200 1320001-1

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 *Electro-Optical and Infrared Systems: Technology and Applications XXI*, edited by Duncan L. Hickman, Helge Bürsing, Ove Steinvall, Philip J. Soan, Proc. of SPIE 13200, Seven-digit Article CID Number (DD/MM/YYYY); (DOI URL).

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

ISBN: 9781510681088
ISBN: 9781510681095 (electronic)

Published by

SPIE

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

Telephone +1 360 676 3290 (Pacific Time)

SPIE.org

Copyright © 2024 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

vii *Conference Committee*

ACTIVE AND PASSIVE SENSING

- 13200 02 **UAV detection: a review of ISL researches over the past ten years (Invited Paper)** [13200-1]
- 13200 04 **Fusion of passive and active electro-optical sensor data for enhanced scene understanding in challenging conditions (Invited Paper)** [13200-3]
- 13200 05 **Multiframe superposition method with adaptive weights based on disturbance estimation residuals** [13200-4]

LIDAR SYSTEMS AND APPLICATIONS

- 13200 06 **Laser in support for effective operation of active and passive EO systems** [13200-5]
- 13200 07 **Multispectral lidar using a two-dimensional dynamic diffraction grating: how to get nanosecond resolution from a projector and a camera** [13200-6]
- 13200 08 **Light detection and ranging sensors for urban air mobility with OOFDMA** [13200-7]
- 13200 09 **Detecting clear air turbulence in urban air mobility by using LiDAR with OOFDMA and a Risley prism** [13200-8]

DETECTORS AND SIGNAL PROCESSING

- 13200 0B **Disruptive imaging field trial (DRIFT) on computational and compressive imaging systems (Invited Paper)** [13200-10]
- 13200 0C **Analysis of surface currents in pBpn superlattice infrared detectors** [13200-11]
- 13200 0E **Achieving the overall shape of a UAV rotor blade by sub-band method on laser micro-Doppler effect** [13200-13]

UK TECHNOLOGY I

- 13200 0F **High-quality factor mid-wave infrared metasurface for methane detection applications (Invited Paper)** [13200-15]

- 13200 OG **Immersive situational awareness and seeing through occlusions at thermal infrared wavelengths** [13200-16]
- 13200 OI **LWIR radiometric signature measurement using micro-bolometer imaging sensors** [13200-18]

UK TECHNOLOGY II

- 13200 OK **Target tracking in a complex simulated world** [13200-20]
- 13200 OL **Optical correction of microscan distortion** [13200-21]

ACTIVE SENSORS AND LASER SYSTEMS

- 13200 ON **Development of a sensor hardened against laser damage independent of wavelength by off-focus imaging (Invited Paper)** [13200-23]
- 13200 OP **Design and development of an integrated LiDAR sensor for autonomous driving: achieved results** [13200-25]
- 13200 OQ **Active shortwave infrared pushbroom imager for security and defense applications** [13200-26]

MODELLING AND SIMULATION

- 13200 OR **Comparing MTDp and TOD for thermal imagers with boost (Invited Paper)** [13200-27]
- 13200 OS **Spectral analysis of low temperature thermal emitters for spectrally accurate IR scene projection** [13200-28]
- 13200 OT **Test, verification, and validation of a multisensor maritime targeting system** [13200-29]
- 13200 OU **Spectral-spatial ground targets for measurement of airborne electro-optical imaging system performance (Invited Paper)** [13200-30]
- 13200 OV **Concept study for the TRM4 display-observer model: effects of glare on range performance** [13200-31]

DETECTORS AND FOCAL PLANE TECHNOLOGY I

- 13200 OW **Latest development on IR detector technology at WAT-VIGO laboratory (Invited Paper)** [13200-32]
- 13200 OX **Emerging technologies for infrared sensing and imaging (Invited Paper)** [13200-33]

13200 0Y **Next generation CMOS TDI detectors** [13200-34]

13200 0Z **Progress on InGaAs-based SPAD fabrication for SWIR detection and imaging** [13200-35]

DETECTORS AND FOCAL PLANE TECHNOLOGY II

13200 11 **Progress on infrared bispectral MCT detectors towards high operating temperature and small pixel pitch (Invited Paper)** [13200-37]

13200 12 **Improvement of a medium wave IR detector product used in a directed infrared counter measures application** [13200-38]

OPTICAL COMPONENTS AND DESIGN

13200 15 **Technologies for adaptive SWIR multispectral imaging** [13200-41]

13200 16 **Monolithic optics: a pick and place contribution** [13200-42]

13200 17 **Quantitative evaluation of image degradation due to stray light in LWIR imaging systems** [13200-43]

13200 18 **Setting point optimisation in continuous zoom lens design** [13200-44]

13200 19 **An innovative control approach for deformable mirrors: balancing control performance, lifespan, and robustness** [13200-45]

DEBELA (DETECT BEFORE LAUNCH) PROJECT

13200 1A **DEBELA: investigations on potential detect-before-launch technologies (Invited Paper)** [13200-46]

13200 1B **Laser warning and pointed optics detection using an event camera** [13200-47]

13200 1C **Zero-shot neuro-symbolic parsing of body keypoints** [13200-48]

13200 1D **Specific processing of mixed pixels for anomaly detection, case study on DEBELA campaign** [13200-49]

IMAGE AND DATA PROCESSING I

13200 1E **Abandoned/removed object detection in video surveillance systems** [13200-52]

IMAGE AND DATA PROCESSING II

- 13200 1F **Analysis of standard deviation normalization in segmented target detection algorithm (Invited Paper)** [13200-50]
- 13200 1G **Optimizing object detection in electro-optical systems with snapshot compressive imaging** [13200-53]

INFRARED SYSTEMS AND APPLICATIONS

- 13200 1I **Long-range dual-band compressive sensing camera (Invited Paper)** [13200-54]
- 13200 1J **Polarimetric image fusion strategies for improving target shape and contrast in remote sensing applications (Invited Paper)** [13200-55]
- 13200 1K **Performance evaluation of a single pixel event-based sensor pixel unit cell optimized for mid-wave infrared sensing** [13200-56]
- 13200 1L **A bolometric hyperspectral camera based on a birefringent interferometer for remote sensing in the thermal infrared (Best Paper Award)** [13200-57]

POSTER SESSION

- 13200 1N **Radiation thermometer using a MWIR detector for room temperature measurement** [13200-60]
- 13200 1Q **Technological concepts for broad- and narrow-band absorbers in uncooled thermal imagers visualizing MWIR and LWIR** [13200-63]
- 13200 1S **The potential of linear polarization for backscatter-blocking and comparison to range-gated technologies focusing on maritime applications** [13200-65]
- 13200 1U **Enhancing stability in Zernike coefficient computation through deep learning for polygonal mirrors of electro-optical satellite payloads** [13200-67]

Conference Committee

Symposium Chair

Ric Schleijsen, TNO Defence, Security and Safety (Netherlands)

Symposium Co-chairs

Chantal Andraud, Ecole Normale Supérieure de Lyon (France)

Robert A. Lamb, Leonardo MW Ltd. (United Kingdom)

Conference Chairs

Duncan L. Hickman, Tektonex Ltd. (United Kingdom)

Helge Bürsing, Fraunhofer-Institut für Optronik, Systemtechnik und Bildauswertung (Germany)

Ove Steinvall, FOI-Swedish Defence Research Agency (Sweden)

Philip J. Soan, Defence Science and Technology Laboratory (United Kingdom)

Conference Program Committee

Gianni Barani, Leonardo (Italy)

Piet Bijl, TNO Defence, Security and Safety (Netherlands)

Rainer Breiter, AIM INFRAROT-MODULE GmbH (Germany)

Lounis Chermak, Cranfield Univ., Defence Academy (United Kingdom)

Bernd Eberle, Fraunhofer-Institut für Optronik, Systemtechnik und Bildauswertung (Germany)

Linda Höglund, IRnova AB (Sweden)

Natan S. Kopeika, Ben-Gurion University of the Negev (Israel)

Malgorzata Kopytko, Wojskowa Akademia Techniczna im. Jaroslawa Dabrowskiego (Poland)

Daniel A. Lavigne, Defence Research and Development Canada, Valcartier (Canada)

Gino Putrino, The University of Western Australia (Australia)

Stanley R. Rotman, Ben-Gurion University of the Negev (Israel)

Frank Rutz, Fraunhofer-Institut für Angewandte Festkörperphysik IAF (Germany)

Dilusha Silva, The University of Western Australia (Australia)

