PROCEEDINGS OF SPIE

Artificial Intelligence and Machine Learning in Defense Applications

Judith Dijk
Editor

10–12 September 2019
Strasbourg, France

Sponsored by
SPIE

Cooperating Organisations
European Optical Society
Cranfield University (United Kingdom)

Published by
SPIE

Volume 11169

Proceedings of SPIE 0277-786X, V. 11169

Artificial Intelligence and Machine Learning in Defense Applications, edited by Judith Dijk, Proc. of SPIE
Vol. 11169, 1116901 · © 2019 SPIE · CCC code: 0277-786X/19/$21 · doi: 10.1117/12.2554471

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 SPIEDigitalLibrary.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 *Artificial Intelligence and Machine Learning in Defense Applications*, edited by Judith Dijk, Proceedings of SPIE Vol. 11169 (SPIE, Bellingham, WA, 2019) Seven-digit Article CID Number.

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

ISBN: 9781510630413
ISBN: 9781510630420 (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

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
SPIEDigitalLibrary.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

AI FOR DEFENCE APPLICATIONS

IMAGE ENHANCEMENT, FUSION, AND BACKGROUNDS

POSTER SESSION

Authors

Numbers in the index correspond to the last two digits of the seven-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first five digits reflect the volume number. Base 36 numbering is employed for the last two digits and indicates the order of articles within the volume. Numbers start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B...0Z, followed by 10-1Z, 20-2Z, etc.

Conference Committee

Symposium Chairs

Ric Schleijpen, TNO Defence, Security and Safety (Netherlands)
Karin Stein, Fraunhofer-Institut für Optronik, Systemtechnik und Bildauswertung (Germany)

Symposium Co-chair

Catherine Barrat, HGH Systèmes Infrarouges (France)

Conference Chair

Judith Dijk, TNO Defence, Security and Safety (Netherlands)

Conference Programme Committee

Fabrizio Berizzi, European Defence Agency (Belgium)
Michel Honlet, HENSOLDT Sensors GmbH (Germany)
Christopher R. Bell, Defence Science and Technology Laboratory (United Kingdom)
David K.J. Gustafsson, FOI-Swedish Defence Research Agency (Sweden)
Sidonie Lefebvre, ONERA (France)
Markus Mueller, Fraunhofer-Institut für Optronik, Systemtechnik und Bildauswertung IOSB (Germany)

Session Chairs

JS1 Unmanned Sensors and Systems (Joint Session 1)
Markus Mueller, Fraunhofer-Institut für Optronik, Systemtechnik und Bildauswertung IOSB (Germany)

JS2 Image Enhancement, Detection and Tracking (Joint Session 2)
Henri Bouma, TNO (Netherlands)
Yitzhak Yitzhaky, Ben-Gurion University of the Negev (Israel)

JS3 Privacy Enhancing Surveillance Techniques (Joint Session 3)
Henri Bouma, TNO (Netherlands)
Yitzhak Yitzhaky, Ben-Gurion University of the Negev (Israel)

JS4 Action and Behaviour Recognition (Joint Session 4)
Henri Bouma, TNO (Netherlands)
Yitzhak Yitzhaky, Ben-Gurion University of the Negev (Israel)

Introduction

A main application of military imaging systems is situational awareness: knowing who and what is in the vicinity and what is their behavior. Image analysis techniques support in the key tasks that enable situational awareness: detection, tracking (follow), classification, identification and behavior recognition of targets or objects. Artificial Intelligence and Machine Learning are increasingly used to assist in these tasks, as the amount of sensor data increases while there are fewer operators and camera operators available.

The first conference on *Artificial Intelligence and Machine Learning in Defense Applications* was held in Strasbourg (France) on 10-12 September 2018, in the framework of the SPIE Security + Defence 2019. The focus of this conference was technology development on Artificial Intelligence and Machine Learning techniques for automatic and machine assisted EO/IR image analysis for defense applications. As for civil applications the algorithms must be able to deal with noisy data and varying conditions.

The first part of the program consisted of joint sessions with the conference on Counterterrorism, Crime Fighting, Forensics, and Surveillance Technologies. In the sessions organized by this conference the topics of Unmanned Sensors and Systems, Image Enhancement, Detection and Tracking, Privacy Enhancing Surveillance Techniques and Action and Behavior Recognition were covered. In the *Artificial Intelligence and Machine Learning in Defense Applications* conference the joint sessions covered the topics on AI in Intelligence, Surveillance, and Reconnaissance, Object Detection and Segmentation. The conference closed with sessions on AI for Defence Applications and Image Enhancement, Fusion, and Backgrounds, respectively. The conference provided an overview of state-of-the-art approaches and new research on these approaches. It discussed possibilities of several neural nets and the lack of operational data for training, testing and evaluation. This volume contains contributions for *Artificial Intelligence and Machine Learning in Defense Applications.*

Launching this new conference was a great pleasure. I would like to thank the SPIE staff for their efforts in preparing the conference and publishing the proceedings. Next, to that, I would like to thank the Program Committee and others who advised in formulating the call for papers. And, of course, thanks to all the authors and the audience for inspiring presentations and interesting discussions. I'm looking forward to next year's conference.

Judith Dijk