PROCEEDINGS OF SPIE

Radar Sensor Technology XXVI

Kenneth I. Ranney Ann M. Raynal Editors

3–7 April 2022 Orlando, Florida, United States

6-12 June 2022 ONLINE

Sponsored and Published by SPIE

Volume 12108

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 *Radar Sensor Technology XXVI*, edited by Kenneth I. Ranney, Ann M. Raynal, Proc. of SPIE 12108, Seven-digit Article CID Number (DD/MM/YYYY); (DOI URL).

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510650923

ISBN: 9781510650930 (electronic)

Published by

SPIE

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

Telephone +1 360 676 3290 (Pacific Time)

SPIE.ora

Copyright © 2022 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.



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

	WAVEFORMS AND PHENOMENOLOGY
12108 02	Performance evaluation and field trial of chirp spread spectrum waveform for low probability of intercept applications [12108-1]
12108 03	Harmonic response vs. target orientation: a preliminary study of the effect of polarization on nonlinear junction detection [12108-2]
12108 04	Analysis of buried target and clutter signature in ground penetrating radar imaging [12108-3]
12108 05	Statistical distributions of POLSAR observables [12108-4]
	SYSTEMS AND APPLICATIONS
12108 06	Development of polarimetric radar product and initial application for airborne HIWC detection [12108-6]
	ALGORITHMS, PROCESSING, AND MICRO-DOPPLER
12108 07	Deep learning for classification of targets using low-frequency ultra-wideband synthetic aperture radar imagery [12108-8]
12108 08	Multiple order difference based radio frequency (RF) signal processing [12108-9]
12108 09	Converting bistatic radar measurements to Cartesian position for tracking [12108-10]
12108 0A	Multiple drone type classification using machine learning techniques based on FMCW radar micro-Doppler data [12108-11]
12108 OB	Semi-supervised attention-augmented convolutional autoencoder for radar-based human activity recognition [12108-12]
	STUDENT RESEARCH IN ALGORITHMS AND PROCESSING I
12108 OC	Radar technical language modeling with named entity recognition and text classification [12108-13]

12108 0D	Three-dimensional anti-jamming array processing for GNSS-based navigational aid inspection [12108-16]
	STUDENT RESEARCH IN SYSTEMS AND APPLICATIONS
12108 0E	Real-time transponder detection using open-source software-defined radio receiver architecture for harmonic radar systems [12108-17]
12108 OF	Design and experimentation of a dual-band, full-polarization, side-looking synthetic aperture radar using an RF system-on-a-chip $[12108-18]$
12108 0G	Fusing SAR and EO imagery using CNN RGB-input channels, feature level, and decision level fusion $[12108-19]$
12108 OH	RF dielectric measurements on engineering fluids for jet impingement cooling [12108-42]
	STUDENT RESEARCH IN PHENOMENOLOGY
12108 01	Application of impulse radar to snow and ice penetration: a case for supporting snow layer modeling and characterizations [12108-20]
12108 OJ	Analysis of antenna array patterns for multiple squad configurations [12108-22]
	STUDENT RESEARCH IN RADAR MICRO-DOPPLER
12108 OK	Experimental analysis of micro-Doppler characteristics of drones and birds for classification purposes [12108-24]
12108 OL	Applying the wavelet transform to radar signals for drone classification using convolutional neural networks [12108-25]
	STUDENT RESEARCH IN ALGORITHMS AND PROCESSING II
12108 OM	Deep learning on trajectory images [12108-28]
12108 ON	Domain fusion based feature extraction for SAR ATR [12108-29]
12108 00	Mobile distributed mesh network optimization with a black box optimizer [12108-30]
12108 OP	Radar applications of orthogonal Sudoku arrays and Costas cubes [12108-31]

	12108 0Q	Generation and estimation of randomly maneuvering target trajectories towards metacognitive tracking radar applications [12108-32]
	12108 OR	Automatic modulation classification of NLFM radar signal in multipath conditions [12108-33]
_		MILLIMETER WAVE RADAR: JOINT SESSION WITH CONFERENCES 12108 AND 12111
	12108 0\$	94 GHz Doppler radar for experimental validation of small UAV micro-Doppler [12108-34]
	12108 OT	G-band FMCW Doppler radar for sea clutter and target characterization [12108-35]
	12108 OU	Concept and design of precise radar sensor for relative navigation in ocean environment [12108-36]
_		POSTER SESSION
	12108 OV	Impact of radar flightpath on synthetic aperture radar image height of focus [12108-37]
	12108 OW	Time-space processing for small ship detection in SAR [12108-43]
	12108 0X	An application of the delay line differentiator for pulse characterization [12108-47]