PROCEEDINGS OF SPIE

Synthetic Data for Artificial Intelligence and Machine Learning: Tools, Techniques, and Applications

Christopher L. Howell
Kimberly E. Manser
Raghuveer M. Rao
Editors

1–3 May 2023
Orlando, Florida, United States

Sponsored and Published by
SPIE

Volume 12529

Proceedings of SPIE 0277-786X, V. 12529

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

Synthetic Data for Artificial Intelligence and Machine Learning: Tools, Techniques, and Applications, edited by Christopher L. Howell, Kimberly E. Manser, Raghuveer M. Rao, Proc. of SPIE Vol. 12529, 1252901
© 2023 SPIE · 0277-786X · doi: 10.1117/12.2690655

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 *Synthetic Data for Artificial Intelligence and Machine Learning: Tools, Techniques, and Applications*, edited by Christopher L. Howell, Kimberly E. Manser, Raghuveer M. Rao, Proc. of SPIE 12529, Seven-digit Article CID Number (DD/MM/YYYY); (DOI URL).

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

ISBN: 9781510661721
ISBN: 9781510661738 (electronic)

Published by
SPIE
P.O. Box 10, Bellingham, Washington 98227-0010 USA
Telephone +1 360 676 3290 (Pacific Time)
SPIE.org
Copyright © 2023 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
SPIEDigitalLibrary.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*

DATA ENGINEERING AND CURATION

12529 03 **Generating synthetic IR imagery to train modern deep learning detection and recognition algorithms to perform on similar real IR data** [12529-2]

12529 04 **Real-data performance evaluation of Unreal Engine synthetic IR data** [12529-3]

12529 05 **Ignorance is bliss: flawed assumptions in simulated ground truth** [12529-4]

12529 06 **Automated image quality alert utility for monitoring video acquisition** [12529-5]

12529 07 **Real-data performance evaluation of composite synthetic IR data** [12529-6]

FIDELITY AND SENSITIVITY ANALYSIS

12529 08 **Fidelity requirements for simulating sensor performance in autonomous ground vehicles** [12529-7]

12529 0A **Sensitivity analysis of ResNet-based automatic target recognition performance using MuSES-generated EO/IR synthetic imagery** [12529-9]

12529 0B **Lazy table building for high-dimensional look up table generation** [12529-10]

SYNTHETIC DATA GENERATION TOOLS I

12529 0C **Adversarial learning using synthetic IR imagery** [12529-12]

12529 0D **A graphical user interface for multi-modal operating condition sampling** [12529-13]

12529 0F **Framework for digital twin creation in off-road environments from LiDAR scans** [12529-15]

SYNTHETIC DATA GENERATION TOOLS II

12529 0G **DyViR: dynamic virtual reality dataset for aerial threat object detection** [12529-16]

12529 0H **Target modeling capabilities in DEVCOM Aviation and Missile Center scene generation tools** [12529-17]

12529 0I **Synthetically generating human-like data for sequential decision-making tasks via reward-shaped imitation learning** [12529-18]

12529 0J **How should simulated data be collected for AI/ML and unmanned aerial vehicles?** [12529-113]

GENERATIVE MODELS FOR SYNTHETIC DATA CREATION

12529 0K **Leveraging synthetic data for AI bias mitigation** [12529-21]

12529 0L **Cyber creative GAN for novel malicious packets** [12529-23]

SYNTHETIC DATA FOR MULTI-DOMAIN AI/ML APPLICATIONS: JOINT SESSION WITH CONFERENCES 12529 AND 12538

12529 0O **Synthetic data for automatic target recognition from small drones** [12529-26]

12529 0P **Multi-agent collaboration environment simulation** [12529-27]

12529 0Q **Generation of high-fidelity signatures for AI/ML training database generation** [12529-28]

SYNTHETIC DATA FOR UNMANNED SYSTEMS TECHNOLOGY APPLICATIONS: JOINT SESSION WITH CONFERENCES 12529 AND 12549

12529 0R **Analyzing synthetic datasets through the training and inference domain gap (Invited Paper, Best Presentation Award)** [12529-29]

POSTER SESSION

12529 0T **Zero shot domain adaptation for x-ray baggage scanning (Best Poster Award)** [12529-32]

12529 0U **Data generation and separation of AM radio collisions with machine learning** [12529-33]

12529 0V **A new deep Q-learning method with dynamic epsilon adjustment and path planner assisted techniques for Turtlebot mobile robot** [12529-34]

12529 0Y **Leveraging synthetic data for robust gesture recognition** [12529-37]

12529 0Z **Leveraging body pose estimation for gesture recognition in human-robot interaction using synthetic data** [12529-38]

12529 10 **A study on improving realism of synthetic data for machine learning** [12529-40]

12529 11 **Out-of-distribution 3D object generation for enhanced pose estimation** [12529-41]

12529 12 **Extending neural radiance fields (NeRF) for synthetic aperture radar (SAR) novel image generation** [12529-42]

12529 15 **Indecision trees: learning argument-based reasoning under quantified uncertainty** [12529-119]

12529 16 **Quasi-synthetic data generation for camouflaged object detection at edge** [12529-53]

Conference Committee

Symposium Chairs

Tien Pham, The MITRE Corporation (United States)
Douglas R. Droege, L3Harris Technologies, Inc. (United States)

Symposium Co-chairs

Augustus W. Fountain III, University of South Carolina (United States)
Teresa L. Pace, L3Harris Technologies, Inc. (United States)

Program Track Chair

David W. Messinger, Rochester Institute of Technology (United States)

Conference Chairs

Christopher L. Howell, DEVCOM C5ISR (United States)
Kimberly E. Manser, DEVCOM C5ISR (United States)
Raghuveer M. Rao, DEVCOM Army Research Laboratory (United States)

Conference Program Committee

Rama R. Chellappa, University of Maryland, College Park (United States)
Celso De Melo, DEVCOM Army Research Laboratory (United States)
Karen Frech, U.S. Navy (United States)
Leonidas J. Guibas, Stanford University (United States)
Sean Hu, DEVCOM Army Research Laboratory (United States)
Kapil Katyal, Johns Hopkins University Applied Physics Lab., LLC (United States)
Dinesh Manocha, University of Maryland, College Park (United States) and The University of North Carolina at Chapel Hill (United States)
Jamileh Mogin, U.S. Department of Energy (United States)
Priya Narayanan, DEVCOM Army Research Laboratory (United States)
Colin N. Reinhardt, Naval Information Warfare Center Pacific (United States)
Stefano Soatto, University of California, Los Angeles (United States)

Antonio Torralba, Massachusetts Institute of Technology (United States)
Vincent J. Velten, Air Force Research Laboratory (United States)
Bryan I. Vogel, DEVCOM C5ISR (United States)
Lori Westerkamp, Air Force Research Laboratory (United States)