

PROCEEDINGS OF SPIE

Virtual, Augmented, and Mixed Reality (XR) Technology for Multi-Domain Operations III

Mark S. Dennison Jr.
David M. Krum
John (Jack) N. Sanders-Reed
Jarvis (Trey) J. Arthur III
Editors

3–7 April 2022
Orlando, Florida, United States

6–12 June 2022
ONLINE

Sponsored and Published by
SPIE

Volume 12125

Proceedings of SPIE 0277-786X, V. 12125

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

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 *Virtual, Augmented, and Mixed Reality (XR) Technology for Multi-Domain Operations III*, edited by Mark S. Dennison Jr., David M. Krum, John (Jack) N. Sanders-Reed, Jarvis (Trey) J. Arthur III, Proc. of SPIE 12125, Seven-digit Article CID Number (DD/MM/YYYY); (DOI URL).

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510651265

ISBN: 9781510651272 (electronic)

Published by

SPIE

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

Telephone +1 360 676 3290 (Pacific Time)

SPIE.org

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.

**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

v *Conference Committee*

XR AND ROBOTICS

- 12125 02 **Immersive display for remote vehicle operation** [12125-2]
- 12125 03 **Factors affecting human understanding of augmented reality visualization of changes detected by an autonomous mobile robot** [12125-3]

DEGRADED VISUAL ENVIRONMENTS

- 12125 05 **Virtual reality framework for design and evaluation of multispectral computer vision algorithms and augmented reality interfaces for enhancing situational awareness in degraded visual environments** [12125-5]
- 12125 06 **Simulating global misalignment of a binocular HMD during a flying and target discrimination task** [12125-6]
- 12125 07 **Investigation and evaluation of a helicopter pilot assistance system for offshore missions in degraded visual environment** [12125-7]
- 12125 08 **Current challenges and mitigations for airborne detection of vertical obstacles** [12125-19]
- 12125 09 **Multimodal cueing and short-term pilot interaction during helicopter low-level operation under automatic trajectory following** [12125-8]

XR TECHNOLOGY ENABLERS

- 12125 0A **Development and characterization of a tabletop fog chamber at Sandia National Laboratories** [12125-9]
- 12125 0B **Critical technology enablers for near-to-eye AR and VR** [12125-10]
- 12125 0C **Dual-color holographic head-up display for aircraft using a digital light processing chip** [12125-11]
- 12125 0D **Motion tracking for augmented and mixed reality: how good is good enough?** [12125-12]

XR FOR TACTICAL SCENARIOS

- 12125 0E **Modeling and analysis of motion data from dynamic soldier state estimation to enable situational understanding** [12125-13]
- 12125 0G **Realtime visual-inertial SLAM integrated with radar data to triangulate targets** [12125-15]
- 12125 0H **Perceptual preference for 3D interactions and realistic physical camera motions on light field displays** [12125-16]
- 12125 0I **Thresholds of perceptual fatigue based on 3D object motion vectors and relative object size in virtual reality** [12125-17]