

# **2023 IEEE International Symposium on Safety, Security, and Rescue Robotics (SSRR 2023)**

**Naraha, Fukushima, Japan  
13 – 15 November 2023**



**IEEE Catalog Number: CFP23SSR-POD  
ISBN: 979-8-3503-8112-2**

**Copyright © 2023 by the Institute of Electrical and Electronics Engineers, Inc.  
All Rights Reserved**

*Copyright and Reprint Permissions:* Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923.

For other copying, reprint or republication permission, write to IEEE Copyrights Manager, IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854. All rights reserved.

***\*\*\* This is a print representation of what appears in the IEEE Digital Library. Some format issues inherent in the e-media version may also appear in this print version.***

|                         |                   |
|-------------------------|-------------------|
| IEEE Catalog Number:    | CFP23SSR-POD      |
| ISBN (Print-On-Demand): | 979-8-3503-8112-2 |
| ISBN (Online):          | 979-8-3503-8111-5 |
| ISSN:                   | 2374-3247         |

**Additional Copies of This Publication Are Available From:**

Curran Associates, Inc  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: (845) 758-0400  
Fax: (845) 758-2633  
E-mail: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

CURRAN ASSOCIATES INC.  
**proceedings**  
.com

# TABLE OF CONTENTS

|                                                                                                                                                                                 |    |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| SEAMLESS: Radio Metric Aware Multi-Link Transmission for Resilient Rescue Robotics .....                                                                                        | 1  |
| <i>Tim Gebauer, Manuel Patchou, Christian Wietfeld</i>                                                                                                                          |    |
| Best Practices to Reduce Fatigue in Small Uncrewed Aerial Systems Pilots .....                                                                                                  | 7  |
| <i>S. Camille Peres, Robin M. Murphy, Ranjana K. Mehta</i>                                                                                                                      |    |
| Quantitative Data Analysis: CRASAR Small Unmanned Aerial Systems at Hurricane Ian.....                                                                                          | 12 |
| <i>Thomas Manzini, Robin Murphy, David Merrick</i>                                                                                                                              |    |
| Redefining Recon: Bridging Gaps with UAVs, 360° Cameras, and Neural Radiance Fields.....                                                                                        | 18 |
| <i>Hartmut Surmann, Niklas Digakis, Jan-Nicklas Kremer, Julien Meine, Max Schulte, Niklas Voigt</i>                                                                             |    |
| Dynamic Simulation Analysis of Effects of Cabin Position on Behavior of Gantry Cranes by<br>Operation of Rail Brakes .....                                                      | 24 |
| <i>Kengo Takahashi, Tetsuya Kimura, Masajiro Abe</i>                                                                                                                            |    |
| A Modularization Concept for Mobile Robots in Search and Rescue Applications .....                                                                                              | 30 |
| <i>Alexander Lel, Alexander Miller, Valerij Sekin, Susann Kriebisch, Ralf Bruder, Christof Röhrig, Thomas Straßmann</i>                                                         |    |
| Multi-Robot Support System for Fighting Wildfires in Challenging Environments: System Design<br>and Field Test Report.....                                                      | 37 |
| <i>Laurent Frering, Armin Koeﬂer, Michael Huber, Sandra Pfister, Richard Feischl, Alexander Almer, Gerald Steinbauer-Wagner</i>                                                 |    |
| Online 2D-3D Radiation Mapping and Source Localization Using Gaussian Processes with Mobile<br>Ground Robots .....                                                              | 44 |
| <i>Jonas SüB, Martin Volz, Kevin Daun, Oskar von Stryk</i>                                                                                                                      |    |
| Accurate Pose Prediction on Signed Distance Fields for Mobile Ground Robots in Rough Terrain.....                                                                               | 52 |
| <i>Martin Oehler, Oskar von Stryk</i>                                                                                                                                           |    |
| Affordance-Based Actionable Semantic Mapping and Planning for Mobile Rescue Robots .....                                                                                        | 58 |
| <i>Frederik Bark, Kevin Daun, Oskar von Stryk</i>                                                                                                                               |    |
| Radar-Inertial Odometry for Closed-Loop Control of Resource-Constrained Aerial Platforms .....                                                                                  | 66 |
| <i>Jan Michalczyk, Martin Scheiber, Roland Jung, Stephan Weiss</i>                                                                                                              |    |
| Absolute Localization in Feature-Poor Industrial Confined Spaces .....                                                                                                          | 74 |
| <i>Rune Y. Brogaard, Robert A. Hewitt, Sarah Etter, Arash Kalantari, Evangelos Boukas</i>                                                                                       |    |
| Requirements and Challenges for Autonomy and Assistance Functions for Ground Rescue Robots<br>in Reconnaissance Missions .....                                                  | 81 |
| <i>Kevin Daun, Oskar Von Stryk</i>                                                                                                                                              |    |
| Hector UI: A Flexible Human-Robot User Interface for (Semi-)Autonomous Rescue and Inspection<br>Robots.....                                                                     | 89 |
| <i>Stefan Fabian, Oskar von Stryk</i>                                                                                                                                           |    |
| ROBO-MOLE: An Assistant Robot System for First Responders in Subterranean Scenarios .....                                                                                       | 97 |
| <i>Hamid Didari, Eva Reitbauer, Christoph Schmied, Matthias Eder, Stephan Schraml, Nizar Aourik, Marius Feilhauer, Rene Kastner, Roland Hieslmayr, Gerald Steinbauer-Wagner</i> |    |

|                                                                                                                                                                               |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Teleoperation for UAVs in Search and Rescue (SAR) - Current State and Future Outlook .....                                                                                    | 105 |
| <i>Robert Ladig</i>                                                                                                                                                           |     |
| A Verification of a Teleoperation Interface for Rescue Robots Using a Virtual Reality Controller<br>with a Door-Opening Task.....                                             | 111 |
| <i>Kotaro Kanazawa, Noritaka Sato, Yoshifumi Morita</i>                                                                                                                       |     |
| Characterizing Evacuee Behavior During a Robot-Guided Evacuation.....                                                                                                         | 117 |
| <i>Mollik Nayyar, Ghanghoon Paik, Zhenyuan Yuan, Tongjia Zheng, Minghui Zhu, Hai Lin, Alan R. Wagner</i>                                                                      |     |
| Disaster Area Recognition from Aerial Images with Complex-Shape Class Detection .....                                                                                         | 124 |
| <i>Rubén González-Navarro, Dahui Lin-Yang, Ricardo Vázquez-Martín, Alfonso Garcia-Cerezo</i>                                                                                  |     |
| Simultaneous 3D Reconstruction and Vegetation Classification Utilizing a Multispectral Stereo<br>Camera .....                                                                 | 130 |
| <i>Johannes Vollet, Stefan May, Andreas Nüchter</i>                                                                                                                           |     |
| SAR Nets: An Evaluation of Semantic Segmentation Networks with Attention Mechanisms for<br>Search and Rescue Scenes.....                                                      | 137 |
| <i>Andrés Salas-Espinale, Ricardo Vázquez-Martín, Alfonso García-Cerezo, Anthony Mandow</i>                                                                                   |     |
| HabitatDyn Dataset: Salient Object Detection to Kinematics Estimation.....                                                                                                    | 143 |
| <i>Zhengcheng Shen, Yi Gao, Linh Kästner, Jens Lambrecht</i>                                                                                                                  |     |
| Autonomous Navigation of Rescue Robot on International Standard Rough Terrain by Using Deep<br>Reinforcement Learning .....                                                   | 151 |
| <i>Hayato Matsuo, Noritaka Sato, Yoshifumi Morita</i>                                                                                                                         |     |
| Improving Drone Imagery for Computer Vision/Machine Learning in Wilderness Search and<br>Rescue .....                                                                         | 157 |
| <i>Robin Murphy, Thomas Manzini</i>                                                                                                                                           |     |
| Development of a Remote Training System for Evacuation Training in Nursing Homes .....                                                                                        | 163 |
| <i>Tetsuya Kimura, Ryosuke Negoro, Rieko Hojo, Atsufumi Yoshizawa, Yuichi Okamura, Tatsue Yamazaki</i>                                                                        |     |
| Fundamental Experiments on Spark Temperature Measurement During Collision Between Small<br>UAV Propeller and Protective Goggles .....                                         | 168 |
| <i>Kosuke Yoshizaki, Hiroki Igarashi, Miguel Angel Salinas Escamilla, Ayumu Miyahara, Toshiro Hoshi, Kengo Takahashi, Toshiyuki Katsumi, Satoshi Kadowaki, Tetsuya Kimura</i> |     |
| Development of a Robust Tracking Target Against Disturbance Noise for Tracking Control of Fire<br>Fighting Robots .....                                                       | 172 |
| <i>Jun Fujita, Hisanori Amano, Kazunori Ohno, Satoshi Tadokoro</i>                                                                                                            |     |
| Dual Use Security Robotics: A Demining, Resupply and Reconnaissance Use Case .....                                                                                            | 179 |
| <i>Geert De Cubber, Emile Le Flécher, Alexandre La Grappe, Enzo Ghisoni, Emmanouil Maroulis, Pierre Edouard Ouendo, Danial Hawari, Daniela Doroftei</i>                       |     |
| Field Report on Experimental Comparison of a WiFi Mesh Network Against Commercial 5G in an<br>Underground Disaster Environment .....                                          | 184 |
| <i>Juan Bravo-Arrabal, C.S. Álvarez-Merino, J.J. Fernandez-Lozano, Jose Antonio Gómez-Ruiz, Anthony Mandow, Raquel Barco, Alfonso Garcia-Cerezo</i>                           |     |

Distributed Realtime Wireless Network Emulation for Multi-Robot and Multi-Link Setup  
Evaluation..... 191  
*Manuel Patchou, Tim Gebauer, Cedrik Krieger, Stefan Böcker, Christian Wietfeld*

**Author Index**