



ARTIFICIAL INTELLIGENCE

Harnessing AI and robotics in humanitarian assistance and disaster response

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AI and robotics can facilitate humanitarian assistance and disaster response, but partnerships with practitioners are crucial.

The Emergency Event Database (EM-DAT) reported 387 natural hazards and disasters worldwide in 2022, with 30,704 lives lost and US\$ 223.8 billion in economic costs (1). Despite the numerous efforts summarized in surveys such as (2, 3), the artificial intelligence (AI) community has faced difficulty in migrating computer vision and machine learning (ML) technologies to real disasters. Accelerating migration was the subject of the Fourth Workshop on AI for Humanitarian Assistance and Disaster Response (AI + HADR), which brought together experts in field operations and AI research. Discussions focused on the brittleness of AI systems and human-machine interaction issues, notably trust, transparency, and the lack of sufficient operator training. The consensus was that continuous engagement between HADR technologists and practitioners is needed during technology development in order to maintain domain understanding, align on objectives, and provide realistic assessments of capabilities of the technologies and operational constraints.

The workshop, part of the 2022 Neural Information Processing Systems (NeurIPS) conference, brought together more than 330 researchers and experts in AI, public safety, humanitarian assistance, and disaster response to help build technologies to address real-world problems that affect those in need. The workshop was organized by Ritwik Gupta of the University of California, Berkeley; Robin Murphy and Thomas Manzini of Texas A&M University; Eric Heim of Carnegie Mellon University; Guido Zarrella of MITRE; and Caleb Robinson of the Microsoft AI for Good Research

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The goal of the AI + HADR workshop series is to bring first responders, disaster managers, and AI researchers into the same room to discuss the realities of using cutting-edge technologies in the field. Humanitarian assistance and disaster response are two disparate yet interconnected efforts. In this context, humanitarian assistance refers to helping people manage economic, political, and social issues as well as the often-long-term recovery, whereas disaster response addresses the near-term issues stemming from a disaster. This workshop targeted how AI technologies can improve both. The presentations and accepted papers were focused on establishing the current state of the practice, versus basic research, in AI for HADR and were organized around three topics where AI can continue to add value: humanitarian assistance, disaster response, and the transition of HADR research to the real world.

Alexa Koenig at the UC Berkeley Human Rights Center anchored the humanitarian assistance discussion. She shared her experiences responding to human rights abuses and discussed how AI could be used to address humanitarian crises. Automatic censoring of graphic imagery is a potentially high-impact near-term technology that could decrease the mental stress on human operators authenticating imagery associated with documentation of human rights violations. Bistra Dilkina, the co-director of the University of Southern California Center for AI in Society, gave a talk on AI and ML systems that are being used to optimize the water infrastructure of Los Angeles for system-level robustness to earthquake

damage. This talk highlighted how city data can be leveraged to improve predisaster planning and mitigate the risk of a humanitarian crisis. The last speaker on this topic was Juan Lavista Ferres, chief scientist and director of the Microsoft AI for Good Lab. His talk detailed how Microsoft is leveraging AI for good—ranging from managing bias and discrimination in large-scale ML models to using computer vision models to help measure the humanitarian crisis resulting from the 2022 Russia-Ukraine conflict. The workshop published two papers that applied AI technologies to improve response to humanitarian crises, specifically on how data collection can improve ML models for poverty prediction (4) and on vegetation forecasting in Africa (5).

Chase Gitter from the Louisiana State Police, Rick Schofield from the American Red Cross, and Bobby Reiner from the University of Washington framed the role of AI in disaster response. Gitter discussed the use of small uncrewed aircraft systems to improve a broad range of emergency operations, including mass gun violence, hostage situations, and crowd management. A specific request he had for the AI community was for edge AI tools that estimate crowd sizes from visual imagery to support timely response to disaster scenes. Schofield spoke about responding to large-scale disasters. His talk highlighted the need for technologists to connect with domain experts to ensure that any development effort addresses real problems. Reiner spoke about building models for infection in the COVID-19 pandemic. His talk detailed the motivations behind the epidemiological model by the Institute for Health Metrics and Evaluation. Reiner discussed the trade-offs made as the pandemic progressed. The workshop published three articles on using AI to improve the response to large-scale disasters including wildfires (6), landslides (7), and disaster risk assessment (8).

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Fig. 1. Overhead oblique imagery collected along Fort Myers Beach, FL, USA after Hurricane Ian in 2022. Disaster operations are supported by imagery like this; AI and ML techniques can have substantial influence on tackling such situations.

Much of the workshop focused on applications of ML to satellite imagery because remote sensing provides an efficient way to observe otherwise inaccessible areas. Fayyen Bastani from the Allen Institute for AI discussed Satlas, a large-scale multi-task dataset and benchmark for advancing tools for remote-sensing data. The workshop published two articles on building infrastructure for image classification on satellite imagery (9,10). This work highlighted the opportunity for deep learning technologies to improve classification tasks on overhead imagery; however, the transition to oblique imagery, like that of Fig. 1, remains an open problem.

By the end of the workshop, four conclusions emerged. First, technologists must work with HADR practitioners at the time of inception to ensure their solutions will have an influence in the real world. All too often technologies address problems that do not exist in practice. Second, widescale adoption of new technology relies on ongoing partnerships with practitioners to guide the transition to operational use. Third, HADR practitioners must be trained to critically evaluate AI to foster acceptance and facilitate communicating areas for improvements. Finally, overhead imagery from increasingly proliferated

satellites and drones represents a substantial opportunity for the development of large deep-learning models that can be used for tasks such as building damage assessment and vegetation monitoring. Building academic-practitioner partnerships and developing new models take time, and it is hoped that the findings from the workshop will encourage the community to produce translative research that will save lives and reduce the humanitarian and economic effects of disasters.

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