REMOTE SENSING AND ARTIFICIAL INTELLIGENCE in the Mine Action Sector

By Martin Jebens [International Committee of the Red Cross]
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Remote sensing and artificial intelligence (AI) technologies are included in discussions of how technology and innovation can improve humanitarian action and international peacekeeping. These technologies have the potential to improve the capacity to assess needs and to monitor changes on the ground and can be useful for both the mine action (MA) and broader humanitarian sectors. Even though remote sensing and AI are not the silver bullet in MA and come with several challenges (e.g., operational and data protection), the International Committee of the Red Cross (ICRC) and the Geneva International Centre for Humanitarian Demining (GICHD) believe that the integration of remote sensing and AI into the MA sector will enhance evidence-based decision making, aiding in determining priorities for surveying and clearance of contaminated areas and enabling the scarce recourses available for MA activities worldwide to be appropriately directed and used as efficiently as possible. On the 20th and 22nd of April, ICRC and GICHD co-hosted a webinar on remote sensing and AI in the mine action sector. The following is a review of the key benefits and challenges discussed during the two days.

In humanitarian mine action (HMA), research and innovation have led to the development and deployment of several alternative methods to identify contaminated areas and for detection. However, these innovations have come with some limitations (cost, training methodologies, limited applicability depending on environmental conditions) and can therefore only be considered as one component of a tool-box approach. The use of high-resolution remote imagery has been tested and evaluated as a valuable supplementary tool for MA teams that require accurate, up-to-date imagery of suspected hazardous areas (SHAs) and confirmed hazardous areas (CHAs); however, past tests and research have been limited.As many countries near the completion of their MA programs, many of the remaining SHAs and CHAs are becoming harder to process and release as they are remote and cover large areas, often with challenging terrain.

Recent papers[1–5] have shown the potential benefits of using airborne remote sensing to detect explosive ordnance (EO). These tests indicate that even though remote sensing may not be a perfect solution, it may be a valuable addition to the efforts to detect EO in certain environments and improve the pace of non-technical surveys (NTS) and other activities. Some of these findings were also presented at the GICHD mine action technology workshop held in Basel, Switzerland, in 2019.

In addition to remote sensing, AI and machine learning are increasingly prominent technologies that can increase the probability of detection while simultaneously decreasing the false alarm rate. AI has the ability to identify objects, analyze big data[6] at an extremely fast pace, and recognize patterns invisible to the human eye. Coupled with remote sensing, AI can quickly transition an MA operation from time-consuming analysis to decision making and

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action. Additional benefits include better situational awareness on the ground, improved safety for clearance personnel, and more effective planning, prioritization, and tasking of MA assets.

On the 20 April and 22 April 2021, the ICRC and the GICHD cohosted a webinar on the use of remote sensing and AI, enabling presenters to discuss recent developments, highlight lessons learned, and discuss several key challenges:

- cross-sectorial work
- data needs and data protection
- region-specific contexts

Key Challenges: Cross-Sectorial Work

Even though HMA is a niche field with unique resource constraints and highly specific operating requirements, it should not remain siloed in its innovative endeavors, but rather open to technical advancements from other sectors.

The interlinked nature of MA calls for an approach that is holistic, coherent, and includes a diverse set of stakeholders. Remote sensing and AI have been developed and implemented among the private sector, academia, and other parts of the humanitarian sector, including the ICRC—who for several decades have employed AI for damage assessments, crop monitoring, and to analyze satellite images. Therefore, considerable knowledge is already available and can be transferred to the broader MA sector. Whereas the private sector is investing in new start-ups and technology companies that can handle the big data generated from crowd sourcing and is developing AI algorithms so that self-driven cars can detect objects in real time, academia is conducting research on how to improve these techniques. In contrast, the MA sector is in the start-up phase of exploiting the potential of big data to improve decision-making. One of the factors contributing to the slow institutional uptake of these methods within MA is a lack of capacity to apply these methods in operational settings due to lack of funding, cooperation, and support. Nevertheless, partnerships between governments, nongovernmental organizations (NGOs), academia, civil society, and the private sector are critical to obtaining the expertise and resources necessary to integrate remote sensing and AI into survey and clearance activities in a more efficient, cost-effective way that lowers the risk for those involved.

Key Challenge: Data Needs and Data Protection

There is a wealth of opportunities to use remote sensing and AI methods when detecting EO or identifying ground contaminator indicators. However, several presenters at the webinar recalled that to benefit from remote sensing data, the sector also needs platforms that can analyze and exploit large amounts of data (e.g., IMSMA[7] or other GIS-software).

To use the potential of AI effectively, computer algorithms need datasets to train the system. In the future, resources for gathering and training AI should be based on real-world data that might account for EO that has been exposed to the elements for a long time and has aged/decayed. In addition, different types of quantitative and qualitative data from crowd sourcing, baseline studies, and conflict history can provide higher-quality data. Moreover, human experience and expertise should be used for analysis, as well as to train systems and validate results.

While important to obtain different types of images of the environment suspected to be contaminated with EO—including areas not known to be contaminated and SHAs—practitioners note images can also contain information on individuals or communities. Therefore, the MA sector must recognize the potential for harm that can result from misused data and determine general ethical principles and guidelines[8] for data use. Whereas the benefits will depend on the nature of the crisis, so too will potential risks and harms. In 2002, after an unplanned explosion at a munitions site (UEMS) in Lagos, Nigeria, the socioeconomic impact was profound because of the thousands of people who were affected. In such circumstances, where metropolitan areas need to function for the millions of people who live within, the use of remote sensing may outweigh the risks of data being misused. However, data might also be used to target populations and cause more damage than good. If MA is taking place in areas populated by internally displaced persons, compromised data could be misused by nonstate actors, which can occur if drones crash or via data hacking. Nevertheless, each project should be assessed individually

Furthermore, when using AI, users should note that the results will potentially be biased by the data used to train the machine. Awareness of the data source is crucial as well as the need to use data that best targets region-specific areas, for example, EO will deteriorate differently in different environments, which needs to be reflected in the training of AI.

Although there is a tendency to continually seek better or more data on a range of issues, the wish for better data could be caused by the lack of our ability to cope with big data. Currently, there are plenty of evidence-based datasets that could advance survey techniques when identifying SHAs via airplane or satellite imagery, as well as remote sensing data from satellites. Moreover, by using machine learning on white papers and reports from the humanitarian sector, these techniques can help validate findings and identify previously unknown contaminated areas and improve desk assessments or NTS in general. AI demonstrates potential in making a valuable contribution to help the MA sector analyze the data that is already available.

Key Challenge: Region-Specific Contexts

Different types of remote sensing such as true color/RGB (Red, Green, Blue) images, thermal images, and ground penetrating radar, etc., will produce varying advantages in different environments. The potential benefit for using remote sensing therefore needs to be addressed in each individual case. Whereas some types might work better in deserts, others might work better in snowy or cold conditions, or in areas with vegetation. The consensus among practitioners is that more testing is needed.

The market for remote sensing platforms is increasing, as many of these solutions are cost-effective and sustainable. Modern unmanned aerial vehicles (UAVs) can be easy to repair in the field, are relatively easy to acquire, and do not need to have a huge impact on resources. However, operators must also consider legal aspects of using UAV´s in their respective regions or countries. Being able to communicate the pros and cons of using remote sensing with national authorities and local communities is therefore necessary. In addition to leveraging UAV imagery, mine action can also employ satellite imagery to generate useful remote sensing data, even though satellite imagery tends to have a lower resolution and is more easily impacted by weather (cloud cover) compared to UAV´s.

Outlook

The ICRC and GICHD firmly believe that the integration of remote sensing and AI (either used individually or together) into MA activities could enhance evidence-based decision making. This will improve prioritization for surveying and clearance activities in SHAs/CHAs and enable operators to better and more efficiently direct the scarce resources available for MA activities worldwide. Remote sensing and AI will also support the MA sector in articulating the positive impact of the work by identifying the development of rural activities such as farming or urban access to infrastructure and services in released areas.[9] Combining increasingly complex MA datasets (i.e., remote sensing imagery) with socioeconomic data will present opportunities to evaluate the risk for individual contaminated areas, which should be used when prioritizing clearance activities.

Although recent hype can oversimplify what can and cannot be done with remote sensing data and AI, these are fundamentally new additions to the mine action toolbox that can improve survey activities. To ensure that we don't spend resources duplicating work or take resources away from getting EO out of the ground, the collaboration between the wider humanitarian and MA sector, academia, and the private sector will be crucial in the future. For this reason, the need for information sharing among the organizations working to mainstream these technologies cannot be underestimated. The "Use of Remote Sensing and AI in the Mine Action Sector" webinar was not a standalone event, as the ICRC and the GICHD are currently developing a platform on which ideas and lessons learned can be shared. In addition, the GICHD plan to use the next GICHD technology workshop, scheduled for November 2021, as an opportunity to continue the important dialogue and exchange of information on remote sensing and AI in MA.

BIOGRAPHIES

Martin Jebens
Weapon Contamination Consultant
International Committee of the Red Cross

Martin Jebens is currently working for the ICRC Weapon Contamination Unit and delegation of Japan, where he is leading a project on how thermal sensing and AI can improve detection of weapons or can be used for other humanitarian needs. Previously Jebens worked in the field of disaster risk management. He has a strong focus on innovation, improved coordination, and planning to reduce risks and uses the SDG´s and the Sendai Framework for Disaster Risk Reduction as guiding tools. He has a background in mine action as GIS manager and drafted IMAS 07.13 on environmental management. He has been appointed to participate in several national advisory boards including the Danish national nuclear emergency group and to advise on climate change adaptation. He holds a master's in disaster risk management and a master's in volcanology, both from the University of Copenhagen.

Rob White
Deputy Head of Division, Standards and Operations
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Rob White is Deputy Head of Division, Standards and Operations at GICHD, a Division that provides services and technical expertise on developing standards and increasing operational efficiency and effectiveness in mine action. The Division focuses on strengthening national capacities to enable greater ownership of mine action operations, in line with national and global strategic priorities. Prior to joining the GICHD, White was working as Director of Development at a UK NGO. He is a past Trustee and later CEO of UK mine action research NGO, Find A Better Way (now Sir Bobby Charlton Foundation) and Chief Operating Officer of Iraqi NGO IMCO. The majority of his mine action career was spent with the Mines Advisory Group (MAG) in various positions including Director of Operations/Deputy Director with responsibility for managing MAG's global operations. He has a master's (with merit) in International Development.

ENDNOTES

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6. Big data is a concept in computer science that broadly covers the collection, storage, analysis, processing and interpretation of enormous amounts of different data (in MA context this could be data collected during NTS; satellite images, remote sensing data, white papers, positions of different objects) The data-sets are too large or complex to be dealt with by traditional data processing software's.
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9. The Use of Remote Sensing and Artificial Intelligence in the Mine Action Sector, 20th and 22nd April 2021, Geneva (Online Webinar), report, May 2021.