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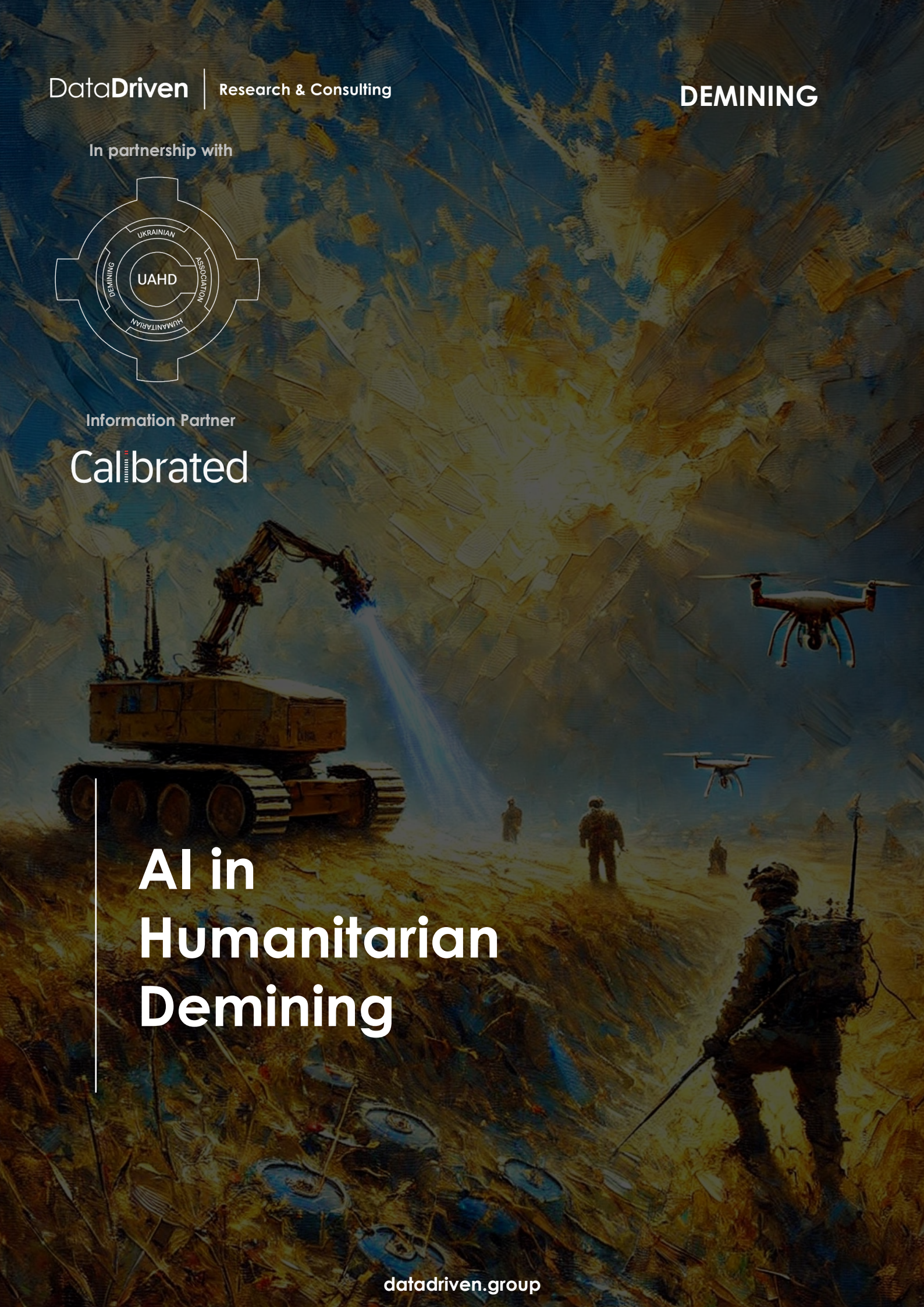

AI in Humanitarian Demining

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Humanitarian demining in Ukraine: an emergency

The true cost of war is often difficult to quantify, as its aftermaths are felt by the population years after the fighting stops. Latest data from 2024 estimates that around 156,000 square kilometers of Ukrainian territory are potentially contaminated with explosive objects such as landmines. This corresponds to an area of around 25% of the country according to the State Emergency Services of Ukraine (SES), or what's the same, four times the size of Switzerland. (Government of Ukraine, State Emergency Service of Ukraine).

Even if this area has been somewhat reduced since 2023 thanks to demining operations, Ukraine has become the most heavily mined country in the world, surpassing Syria and Afghanistan. The scale of mine contamination is thought to be the largest since the Second World War and it would take decades – if not more – to completely clear it using contemporary methods (Time).

Mine action comprises a series of pillars aimed at reducing the risks posed by mines or other explosive remnants of war. Humanitarian demining is a group of activities carried out to clear land for civilian purposes (UNMAS). Beyond clearance of the mines (e.g. detonating or disposing them), demining requires a combination of efforts such as technical and non-technical surveys aimed to facilitate mapping and marking contaminated areas.

Mine clearance, although vital for populations to be able to live safely, is a challenging process: it is high cost, time-consuming, labor intensive and dangerous. Area suspected of contamination must be examined in different stages, beginning with a non-technical survey that allows to distinguish mined plots from those free of contamination. A technical survey then follows in the polluted areas identified, involving a more thorough field study that will determine the exact locations to be cleared. The process is finalized when operators conduct the clearance of the area. All steps considered, the World bank estimates that the total cost of demining Ukraine will amount to $37 billion (UN News). For small and medium-sized farmers or landowners, the cost of demining their land parcels is in many cases unattainable, as it often exceeds the value of the plots.

Desperate times require innovative solutions: enter AI

Faced with these challenges, Ukrainians have capitalized on their burgeoning IT and engineering ecosystem to come up with innovative solutions based on AI. Artificial intelligence - which is already extensively used in several aspects of defense by the Ukrainian army - is now finding its way into humanitarian demining. The sector is

growing in response to soaring needs, as is demand and competition for skilled engineers.

The premise is simple: AI promises to make demining more cost effective, safer and faster. Ukrainian startups are training their AI models to visually detect landmines and they are developing smart autonomous drones that can act as remote metal detectors. These drones have a similar accuracy level to professional human operators (i.e. who would inspect the land visually and using handheld detectors), but they can perform detection tasks significantly faster than human sappers while avoiding personal risks.

For tech specialists and demining practitioners alike, AI's biggest added value is currently twofold. First, it can help scale non-technical surveys and landmine mapping, assessing the magnitude of pollution in suspected hazardous areas. While this step represents a relatively small cost of the complete clearance process, the other side of the coin is that being able to exclude unpolluted hectares of land from subsequent technical surveys saves huge amounts of time and money down the line. For instance, having information from largescale AI-powered screening that a given area is not contaminated with landmines allows farmers to restart cultivating it and recover part of their revenues. It also helps focus clearance efforts on those areas that require the most attention.

The second added value of AI in humanitarian demining is in quality control checks conducted after mine clearance. This step is usually conducted by Ukrainian authorities to verify that no unexploded materials have been accidently left uncleared. The current challenge is that it isvery complicated task to scan the entirety of the concerned areas due to the high level of effort required. Drones using AI can thus have a comparative advantage in this regard, as they allow operators to scan entire territories and add an extra level of reassurance that no landmine remnants are left on the ground.

These promising advances have been recognized by national and international authorities. In the latest round of mine-detection innovations testing organized by the UNDP in May 2024, the participating teams achieved encouraging results in the use of advanced remote sensing technologies in humanitarian demining. Further evaluation and refining are still necessary to ensure that these technologies can be safely deployed and be effective even in the most complex settings. However, stakeholders in the field are hopeful they have laid the groundwork for innovation and that their operationality will be a reality in the near future.

Current achievements

As of today, Ukraine has already secured international support from the leading company Palantir, which aims to accelerate the analysis and implementation of humanitarian demining processes.

Certain unmanned aerial vehicles with artificial intelligence-based mine detection technologies are already operating on the ground at the expense of donors. These can be both devices capable of real-time recognition and mapping (for example, the AI Land Systems product) and systems that analyze the information (for example, supplied by the international company SafePro Group).

However, all of these achievements are tied to the key issues described above. Which, at the same time, may have some specific solutions in the context of AI technology.

Considering the further development of military and technical sciences as directly related to the elements of artificial intelligence and machine learning, we can talk about the further potential of using proven technologies for both civilian purposes and technical intelligence on the battlefield.

Innovations include risks

Usage of the AI in demining may lead to mistakes in spotting, which may result in serious consequences. There're two main mistakes in the work of spotting AI, the false-negative and false-positive.

A false-negative means that there is an explosive device, which hasn't been detected. Such mistake may occur due to the imperfection of AI and sensors or a lack of the latter, e.g. mines hidden in foliage can't be spotted by the AI analysing data from the optical sensor only and plastic mines can't be spotted by the magnetometer. False-negatives are considered as the primary problem as they may lead to serious consequences.

On the other hand, a false-positive phenomenon is an immense problem as well. On the contrary to false-negative, it occurs when non-existing explosive devices are detected by the AI. The false-positives are considered as minor mistakes compared to false-negatives, as they may result only in extra expenditures of time and finance.

Even though the spotting technology is able to detect mines and UXO with great precision, at the level of 80-95% of successful spotting. The further improvement of the technology is limited due to the capabilities of sensors. Further machine learning will presumably lead only to slight enhancing of accuracy and decrease in the number of mistakes. However, the implementation of new sensors and complex usage of them may result in significant development in the spotting precision.

To combat this issue, the AI is already being trained on live examples of detected mines via other methods of mine detection, e.g. infrared and thermal vision.

Immense effort required to make it possible

Training of mine spotting AI isn't hard as it does not require as much computing power as generative AI, however the process of training is extremely tedious as a great number of pictures and other data from sensors has to be processed. Therefore training requires a huge database of images with the marks of the object to be detected by the AI, so a lot of people have to manually look through images and make appropriate marks for an AI to detect a real mine.

AI is not a panacea, but a tool

Unfortunately, even with advanced machine learning and usage of a greater number of mine-spotting sensors, the technology presumably will never reach 100% accuracy

rate due to the diversity of mines and UXO and limited capabilities of sensors. As well, even a 98-99% precision rate does not mean we can fully rely on it, so additional searches will always be necessary.

However, the technology will be very useful for mine-searching teams to boost efficiency and effectiveness and reduce the cost of demining. As well, the usage of AI increasingly enhances the safety of demining teams as even before the demining works they are aware of the location of the majority of mines.

International support is essential in scaling AI use in demining

The impact of landmines on human security seems evident, but there's much more to it beyond posing serious threats to bodily integrity. Unexploded ordnance has substantial negative repercussions for the country's economy. It affects the ability to cultivate the land, impacts the free movement of people and goods, and puts a burden on local emergency services. For a country in which agriculture constitutes an important share of GDP, extensively mined areas entail reduced agricultural production and exports. This means an important loss in revenue, not to mention other consequences such as the disruption of global supply chains impacting food provision to fragile countries.

Considering these numerous ramifications, Ukraine's partners should make humanitarian demining a priority in recovery and reconstruction efforts. In essence, multilateral cooperation is what brought about the advent of mine action as we know it today. Engaged NGOs, concerned individuals and nation states came together in a successful global campaign that brought the Anti-Personnel Mine Ban Convention into being (UNMAS). The international community has since then been at the forefront of humanitarian demining efforts.

In 2022, donors provided $798.4 million in international support to mine action, representing almost a 50% increase from 2021 and being the highest level of annual funding recorded. From these, the United States and the European Union represent the largest donors, while Ukraine tops the list of recipient countries (International Campaign to Ban Landmines, 2023). Nonetheless, removal of landmines and explosive remnants of war continues to be a relatively small share of all official development assistance (ODA) (OECD, 2023).

What's more, international NGOs and UN agencies receive most of the funding for mine action, accounting for 37% and 10% of funding respectively. In contrast, international assistance channeled through national NGOs accounts for less than 1% of total funding (International Campaign to Ban Landmines, 2023). This glaring lack of direct funding severely hinders the ability of Ukrainian demining operators to conduct clearance activities. This is why, big INGOs which receive funding from foreign donors are currently one of the few active players operating in the field.

Limited international funding also impacts the development and prospects of Ukrainian companies experimenting with AI-powered technologies for humanitarian demining. Without external support from partner countries or the private sector, they can hardly afford the high cost of necessary R&D activities.

Conclusion

AI in demining is an extremely innovative response to the challenge of mine pollution, which is able to significantly boost the speed of demining and reduce its cost by cheapening the mine-spotting expenditures of time and finance

Now Ukraine is requiring greater international support to scale this technology to facilitate its recovery and reconstruction. The development of AI will reduce time necessary for full demining, preventing post-war casualties of the civilians and allowing the farmers to use non-contaminated lands. As well this technology makes demining safer for the demining teams.

However, development in AI may not replace more traditional ways of demining and does not guarantee absolute accuracy of spotting. Therefore, it'll allegedly be used in tandem with more conventional technologies to enhance accuracy, decrease cost and increase safety of the process.

Authors: Ana Cobano Cuesta, International Security Researcher; **Borys Knysh,** PhD in Machine Learning, DataDriven expert council member; **Anton Tabur,** Lead Consultant of 'Defence & Demining' Practice of DataDriven; **Marko Kuzmenko** and **Andrii Lisnyi,** DataDriven consultants.

DataDriven Research & Consulting

L: UNIT.City, Ukraine, Kyiv, str. Dorohozhytska, 3

E: office@datadriven.group

W: https://datadriven.group

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