Mine-suspected area reduction using aerial and satellite images

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The problem of area reduction is recognized by the mine action community as being at least as crucial as the problem of close-in detection and consists of finding *where the mines are not*. Area reduction means finding the locations for which the probability of having a mine equals zero and the probability of having an alarm equals the probability of false alarm. Therefore, area reduction with classical tools is affected by the high false alarm rate of current sensors, making the corresponding operations slow, tedious and resource-demanding. Further, it is well known that in most cases a small part of the suspected areas is actually mined. This means that a broader approach is needed, which accounts for *a priori* knowledge. Indeed, if no *a priori* knowledge is available about context such as conflict history, strategies and tactics of the parties, communication networks, terrain configuration, power lines, land use, etc.., the *a priori* probability $p_M(\mathbf{x})$ of having a mine in a given location $\mathbf{x}$ is distributed uniformly and the only demining methods are the classical ones. On the contrary, if *a priori* information is available on the distribution of $p_M(\mathbf{x})$, especially by deducing from the context where the mines are certainly not (*e.g.* agricultural fields in use) and where the mines are possibly present (*e.g.* along the confrontation lines, in the vicinity of trenches, on tops of hills that are possible artillery positions, etc.), it makes sense to build a risk map ($p_{M/\text{context}}(\mathbf{x})$) of the suspected areas. This assumes to define a list of indicators of mine presence ($p_{M/\text{context}}(\mathbf{x})$ is not negligible) and absence ($p_{M/\text{context}}(\mathbf{x})$ is close to zero) as well as a list of processing tools and methods to detect them. One of the most promising methods to build risk maps consists of using aerial and satellite data, associated with context and ground truth data collected during field campaigns. Modern remote sensing tools as land use classification, anomaly detection, change detection and data fusion methods are then used to produce risk or danger maps. The main advantage of this approach is that it allows for reducing areas located in regions that cannot be accessed without very costly safe lanes and full safety procedures that are mandatory when entering minefields. Further, the assessment of areas for reduction and assessment of spatial danger distribution can be performed in shorter time over large areas.

The SMART project funded by the European Commission is a good example of this approach and its methodology will be discussed in detail. SMART provides the human analyst with a GIS-based system augmented with dedicated processing tools and methods designed to use multispectral and radar (full polarimetric SAR) data in order to assist him in his interpretation of the mined scene during the area reduction process. The use of SMART includes a field survey and an archive analysis in order to collect knowledge about the site, a satellite data collection, a flight campaign to record the data and the exploitation of the processing tools by an operator to detect indicators of presence or absence of mine-suspected areas. With the help of a data fusion process based on belief functions and fuzzy sets the operator prepares thematic maps that synthesize all the knowledge gathered with these indicators. These maps of indicators can be transformed into *risk maps* showing how dangerous an area may be according to the location of known indicators and into *priority maps* indicating which areas to clear first, accounting for socio-economic impact and political priorities.

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