European Project of Remote Detection: SMART in a nutshell

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Abstract

This paper shortly describes the principles and ideas behind the project SMART, a European project intended to help Mine Action Centres (MAC) or Mine Action Authorities (MAA) in their task of area reduction by providing a GIS-based environment with specific tools to ease the interpretation work of the operator. Using multi-spectral optical data as well as SAR data obtained during a flight campaign in Croatia and satellite data from before the conflict, the tools will help the land-cover classification and the detection of indicators of presence or absence of mine-suspected areas. The results of these tools will be given to a data fusion module that will summarise all data and contextual information available to facilitate the creation of *maps of indicators* from which *mapss of danger* can be derived.

A more detailed and technical description of SMART has been given – and some results described – in [13]. This paper focuses on the principles of the project and shortly presents some new results.

1 Area reduction: a key process

Area reduction has been recognized as a mine action activity where reduction in time and resources could help a lot. Long-term empirical data from CROMAC, the Croatian Mine Action Center, show that we can estimate that around 10% to 15% of the suspected area in Croatia is actually mined. The minefield records alone do not contain enough information for the proper allocation of limited de-mining resources to really-mined areas. Their completeness and reliability are not high enough. Decision makers need additional information. SMART is intended to provide some of this additional information that would help in two ways: it can reduce the suspected area on some places and reinforce the suspicion of others. The goal of the SMART project is to provide a GIS-based system – the SMART system – augmented with dedicated tools and methods designed to use multispectral and radar data in order to assist the human analyst in the interpretation of the mined scene during the area reduction process.

The usefulness of such image processing tools to help photo-interpretation has already been studied: the possibility to process automatically a large amount of data and help a visual analysis is among their advantages [6] [7].

The use of SMART includes a short field survey in order to collect knowledge about the site, a flight campaign to record the data – multispectral with the Daedalus sensor and SAR with the E-SAR –, and the use of the SMART system by an operator to detect indicators of presence or absence of mine-suspected areas. With the help of a data fusion module based on belief functions [1][9][10][11][12] the operator will prepare thematic maps that will synthesise all the knowledge gathered with these indicators. These maps of indicators can be transformed into *danger maps* showing how dangerous an area may be according to the location of known indicators. These maps are designed to help the area reduction process as described in the present paper.

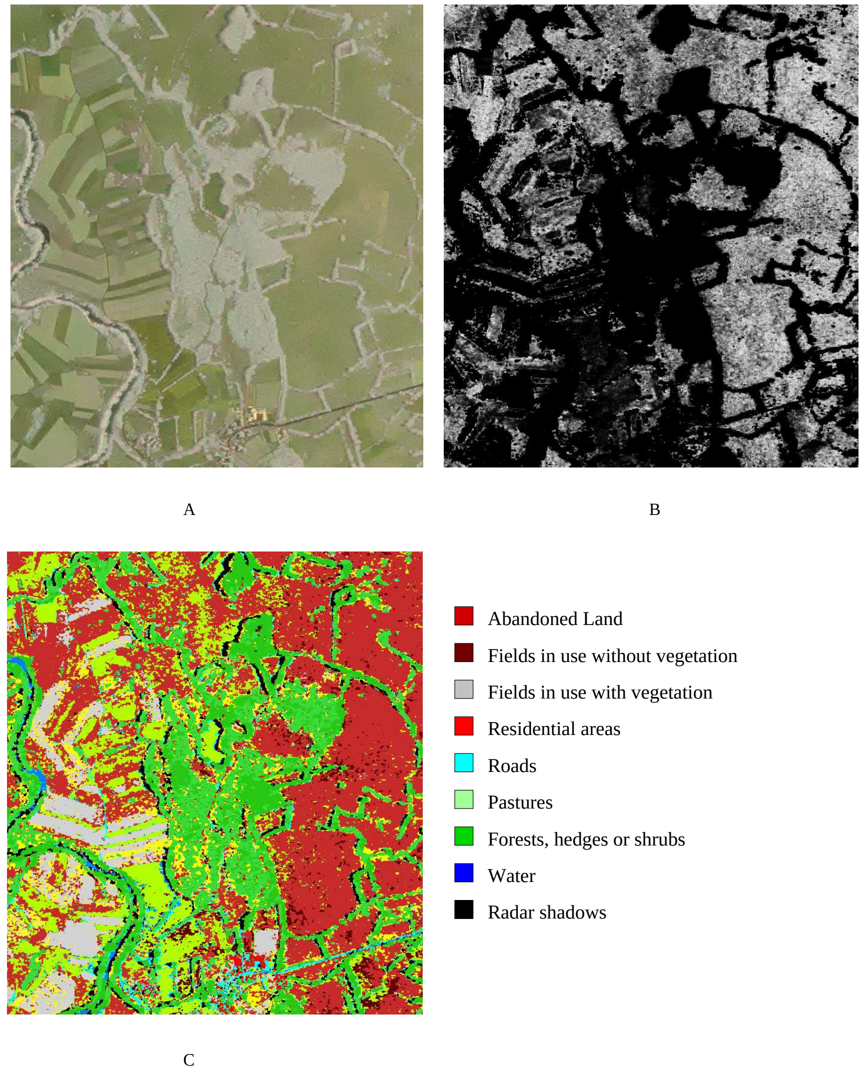

Figure 1: A: part of the speckle-reduced polarimetric L-band image (R:HH, G:HV, B:VV) B: "detection image" for abandoned land (in bright). C: SAR classification results

2 Reducing the suspected area with SMART

The use of SMART can help technical surveys and reduce the clearing of non-risky or non-hazardous areas. Experience shows that, in parts of the country that are considered to be suspected, there are areas actually in agricultural use. Some farmers cannot wait for the official reduction or clearing of their fields and take the responsibility to clear them by themselves or have them cleared unofficially – leading sometimes to incomplete clearing or casualties. These behaviours lead to discrepancies between reality and CROMAC's records of suspected areas. By using multi-spectral and SAR data and processing them to provide a classification of the areas, an operator of SMART can quickly have an objective point of view of the real land cover and land use of a large, theoretically-suspected area. Once the use of SMART has updated the MAC's records and identified cultivated fields inside suspected areas, a short field survey – shorter than what would have been needed without SMART – can be organised to determine if these fields can be officially declared reduced. Figure 1 presents a result of classification performed on SAR data. See [4] for more details including a quality assessment of this classification by confusion matrix and [13] for results on Daedalus classification.

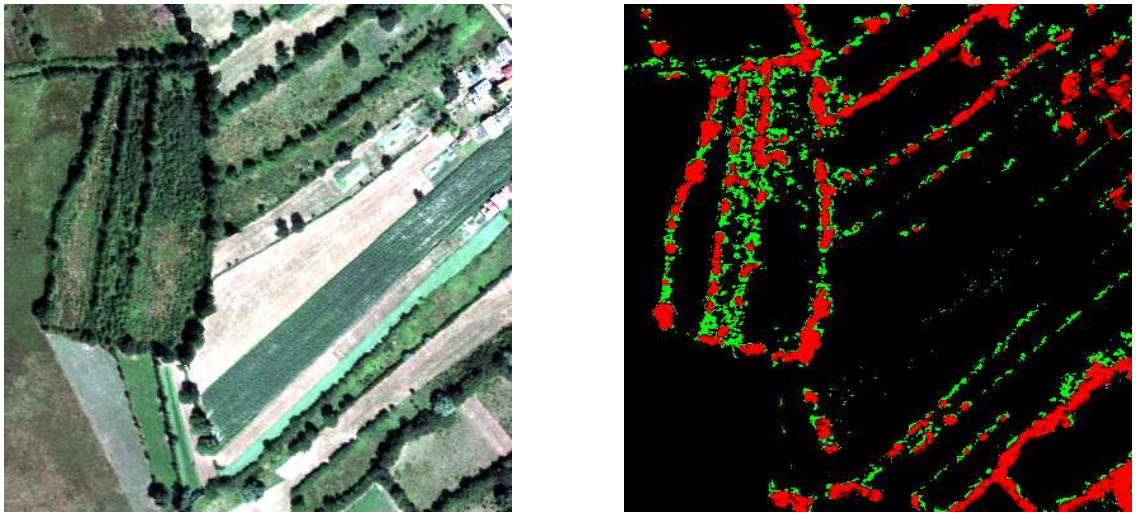

Figure 2: Left: a 400m x 400m area in Croatia as seen on optical data. Right: Detection of hedges (green) and trees (red) from SAR data. Images courtesy of DLR

Using of satellite data from before the war can help determine if a field that is abandoned now was already abandoned before the war. If this is the case the neglected state of the field cannot be attributed to mine infection – although it does not mean that the field is not mined.

3 Suspicion reinforcement

The use of SMART can also help to detect abandoned fields in suspected areas, thus reinforcing the suspicion about these fields. For instance before the contamination by landmines, agricultural fields and pastures in Croatia were enclosed by hedges but rarely with trees. If some fields are abandoned and not used, their borders change; hedges become mixed with smaller trees; bushes grow inside the field borders; low bushes become small trees. The trees and bushes inside the field or at its borders are significant indicators that the field is abandoned.

Detecting abandoned areas can be done by classification of multi-spectral data. By making it possible to make the difference between trees and bushes, SAR provides also very valuable information for this analysis. Since hedges were often used as hiding places and may therefore be mined, they are important indicators of mine-suspected areas. See Figure 2 for an example of the use of SAR data to automatically make the difference between trees and hedges.

If a field is abandoned now, it may be because the soil is simply not suited for agriculture. Using satellite data from before the war can help to determine if the field was cultivated then. If it was, then it reinforces the suspicion.

Multi-spectral data can also be used to detect locations where creating a minefield would have made sense: river shores, forest borders, crossroads, bridges and any other places that are better located on images than on old and obsolete maps. See also [13] for results on change detection focusing on roads and paths.

As a general rule all information gained from the use of SMART must be appraised by the operator.

4 From *indicator maps* to *danger maps*

The *indicator maps* show the locations of the various indicators of presence or absence of mine-suspected areas that have been gathered. They synthetise the knowledge that has been accumulated during the area reduction process. The *danger maps* show how likely it is that a location may be mined.

To create *danger maps* from *indicator maps*, *danger zones* are defined near indicators based on expertise on the mine situation. For instance borders of forests on Croatia are suspect. So danger zones around forest

Figure 3: Discrete 'danger map' of Glinska Poljana (preliminary) Red: Danger (buffers) Orange: Danger (areas no longer in use) Green: No danger (residential areas, cultivated areas...) Other: No status (forests) Source: ULB

borders are drawn. The size of these zones are defined from mine action expertise. See Figure 3 for an example of what a danger map will look like.

5 Limitations

The general knowledge used in SMART is strongly context-dependent. It has been currently derived from the study of three different test sites in Croatia chosen to be representative of the country. In the case of another context a new field campaign is needed in order to derive and implement new general rules. Before using SMART the list of indicators must be re-evaluated and adapted. For instance it has been noted that the asumption that a cultivated field is not mined, although quite valid in Croatia, may not apply in other countries such as South Africa or Colombia. It must also be checked if the indicators can be identified on the data and if the new list is enough to reduce the suspected areas.

6 Conclusion and acknowledgment

Despite these expected limitations the ideas presented here make us confident that SMART has the technical potential to be a working solution for an airborne general survey applied to area reduction.

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http://www.smart.rma.ac.be/

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