Space and airborne Mined Area Reduction Tools

Goal of SMART:

SMART aims at helping the human analysts in their interpretation tasks by providing the end-users with a methodology and tools, which can be used later as a baseline for future standards, **for mine suspected area reduction** in South Eastern Europe.
SMART does not aim at solving automatically the problem of mine suspected area reduction. In security problem solving, involving human life, it is important to leave the final decision to end-user analysts.

Research and Development Phase (Object of SMART):

1. the selection of adequate spaceborne sensors, as well as airborne sensors mounted on an airship including:
   - sensors providing raw data from which it is possible to extract **information** useful in the mine action context, that is:
     - **SAR sensors** in different frequencies (full-polarimetric and dual pass interferometric L- and P-band , VV-polarisation C- and X-band) and
     - multi-spectral sensors (**Daedalus line-scanner**);
   - very high resolution "visual" airborne sensor (typically a **RMK camera**) and/or "visual high resolution spaceborne sensors (typically KVR), especially to be used by an image analyst;
2. planning and performing the airborne **data acquisition campaign**, as well as the evaluation of the use of a **zeppelin airship** as platform for data collection;
3. the organisation of **on-site collection of ground-truth data and context information**;
4. the development of interpretation tools and methods including **land cover classification**, **anomaly detection** and **data fusion**;
5. the **integration** of the data, meta-data, context information **in the end-users' mine action management system**;
6. **analysis** by image-analysts (with minefield survey expertise) **of the results**, using the produced tools and methods integrated in the end-users' GIS;
7. the design of ***danger maps*** summarizing all collected information
8. the **validation** of the use of the developed methods and tools by the end-users.

SMART Innovation:

A **correct choice of sensors** and **well-adapted processing tools** for landcover classification, anomaly detection and data fusion are expected to enable SMART to offer the end-users **validated tools and tools,** and **protocols** in a **validated environment** that can **assist** the human survey experts in their effort to enhance the general assessment survey by reducing the suspected areas.
The **SAR in the L band** is known to characterise the bio-mass and has penetration capabilities through the vegetation (e.g. forests).
Some other SMART innovations can be found in

- The combination of **ground** measurements, features from **air- and spaceborne** data and **context** information.
- The development of appropriate tools and methods for **landcover classification, anomaly detection** specific for mine action.

Developed tools and methods for specific landcover classification, anomaly detection and data fusion, providing appropriate and efficient technologies and aiming at obtaining a safer, more reliable, more cost-effective, more efficient and more user-friendly monitoring system, will **assist** the end-user analysts in **all** phases of mine clearance and particularly for enhancing general assessment survey. This is **the global innovation** of the project.
Because of its involvement in several national and international mine actions research programs, the SMART consortium is aware of the difficulty of the mine action problem and aims not to offer a silver bullet solution for landmine detection but only to adopt a **realistic approach** by building **tools and methods in an environment** that will assist the end-users.

SMART Partners:

TRASYS SPACE	***TRASYS*** is the administrative project co-ordinator. Its technical involvement concerns the integration of data, tools and methods from different partners in a central GIS-based database.
	Renaissance represents the Signal and Image Centre of the Royal Military Academy of Belgium. Its large experience in this field justifies its role in the project as technical co-ordinator and developer of tools for the data fusion, land-cover classification and anomaly detection modules. Renaissance also contributes in the pre-processing task.
ULB IGEAT	***ULB*** *(Université Libre de Bruxelles)* are involved in the land-cover classification module, the ground truth data collection campaigns and the design of *danger maps*.
DLR	***DLR*** *(Deutsches Zentrum für Luft- und Raumfahrt)* contributes with its Experimental Synthetic Aperture Radar, Daedalus scanner and RMK sensor. DLR is also responsible for the SAR and optical processing and the coherence map generation.
TELECOM PARIS	***ENST*** *(École Nationale Supérieure des Télécommunications)* participate in the data fusion module and the land-cover classification module. ENST also contribute to anomaly detection.
Zeppelin	***Zeppelin*** participates with its airship to an airborne data test.
hcr	***CROMAC*** *(Croatian Mine Action Centre)*, the end-users of the project, are involved in the data collection module, the validation module and the protocol definition module. CROMAC also advise the partners about the usefulness of their ideas.
RST	***RST*** is mainly interested in the follow-up of the project and set-up of the later exploitation, especially in designing a fully polarimetric SAR system to be installed on board of a zeppelin.
IXL	***IXL*** is mainly interested in the follow-up of the project and set-up of the later exploitation, especially in ruggedizing the exploitation software.

Exploitation Phase (After SMART):

The expected methodology that service providers will use can be summarised into the following steps:

1. **analysis by image-analysts** (with minefield survey expertise) **of the context information**, supported by an on-site data collection campaign with digital ortho-photo maps at large scale if available;
2. **planning of the airborne survey missions**;
3. **airborne survey missions** with X-, L-, C- and P-band SAR sensors, a multispectral line-scanner, providing data for information extraction, and a very high resolution camera (RMK), and/or the purchase of **high resolution "visual" satellite images** (e.g. KVR);
4. **running of the developed tools and methods into the adapted GIS**, on the available high-resolution spaceborne and/or airborne data set in order to get the useful information, with human intervention at any steps;
5. **analysis** (by image analysts) of the very high-resolution images, **making use of the GIS functionality and taking into account the computed mine-action-oriented information**, made available by the GIS;
6. **report on decision making for area reduction through *danger maps***, planning and resource allocation.

SMART Contact Addresses:

- project leadership -
Jacques Willekens
TRASYS SPACE
Avenue Ariane 7
B-1200 Brussels
Belgium
e-mail: Jacques.Willekens@trasys.be

- technical management -
Prof. Marc Acheroy
Signal and Image Centre, Royal Military Academy
Av. de la Renaissance 30
B-1000 Brussels
Belgium
e-mail: Marc.Acheroy@rma.ac.be