Upgrade of the Advanced intelligence decision support system for mine action in project TIRAMISU

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Abstract

Since the reduction of the suspected hazardous areas (SHA) is a long lasting and expensive process and considering that it requires collecting additional information from the depths of the SHA, there was a need for a new tool designed to assist the experts and managers in their decisions. To fulfil this need, the Advanced intelligence decision support system (AI DSS) was developed and operationally implemented by the Faculty of Geodesy of the University of Zagreb (FGUNIZ) and the CROMAC Centre for Testing, Development and Training Ltd. (CTDT), (They are co-owners of the AI DSS), starting from the generic methodology of SMART [EC 2001] and new developments and advancement supported by the Croatian Ministry of Science [Fiedler et al, 2008]. The AI DSS is an operational system that already was used and yielding good results in Croatia [ITF, CTDT, 2010] and it has also been used with success in Bosnia and Herzegovina [ITF, CTDT, 2011]. The objective in TIRAMISU is the advancement of the AI DSS in an operational context: a) advancement of data acquisition within the AI DSS, b) advancement of processing and interpretation of data (images, contextual data, expert and common knowledge) within the existing operative AI DSS. Research for the project TIRAMISU should result in an upgrade version of existing AI DSS, AI DSS should evolve into T-AI DSS.

1. Introduction

The aim of AI DSS is to support decision making about the SHA, respectively to enable reliable assessment of the SHA, propose areas that could be excluded from the SHA, define areas that are suspected but never have been considered as suspected, change categories, all this without deminers' entering into the SHA. The AI DSS combines [Bajic, 2010]: a) analytic assessments and derivation from the Statements of Operational Needs about the availability and quality of the data and information in the Mine Information System (MIS) and geographic information system (GIS) of the Mine Action Centre (MAC); b) airborne multi sensor imagery acquisition and usage of satellite imagery that provide new data, information and evidences about the SHA state (the indicators of mine presence and mine absence) with high accuracy and confidence; c) the multilevel fusion and multi-criteria, multi-objective processing, interpretation and production of outputs (position of indicators of mine presence or absence, risk-weighted map, confidence of risk-weighted map, confidence of proposed reduction map and controversy map [Krtalic, 2012]).

The AI DSS, based on space borne and airborne assets, is aimed at and suitable for areas where access is not possible on the ground, where there is MIS (geographical, and contextual data), or where ground based technology is too costly. The advanced intelligence technology was developed and deployed into operations of humanitarian mine action in 2008/2009 [ITF, CTDT, 2010], [ITF, CTDT, 2011]. During these projects, certain disadvantages and limitations of the current system have been noted. Furthermore, experts in the deployment of explosives and land mine obstructions, military experts who know war history on the considered terrain and experts in mine action have to derive general and special requirements regarding the difference between available and needed information and data that should be provided through the implementation of AI DSS.

On the basis of these disadvantages, limitations and the generally defined user needs and requirements, requirements for the needed upgraded design, which should make it possible to fill the gaps between the actual functions and the parameters of AI DSS and T - AI DSS was defined and elaborated thoroughly in D220.1_v2: Non-Tehnical Survey Tool Description, TIRAMISU, 01/01/2012 [D.220.1, 2012] (one of the deliverables within project). Detailed elaboration and the beginning of the study were the objective of the first year of the project. Research should be conducted in terms of upgrading existing operating AI DSS. The gaps within the existing AI DSS should be noted and the requirements for the research defined, whose results will eliminate these gaps and improve them or just improve them. The 21 requirements, for filling the gaps, were defined and described.

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2. Requirements

The 21 requirements, for filling the gaps, were defined and described [D.220.1, 2012].

2.1. Tehnical requirements

Technical requirements were related to:

- finding suitable types of platforms for T-AI DSS,
- advancement and re-designing of airborne equipment (according to the above statement),
- stable electricity supply for the system,
- securing a stable GPS signal, without losing the connection,
- hardware and software limitation for parametric georeferencing of the hyperspectral (cubes) data.

Some of these conditions have been partially met before and in the first year of the project TIRAMISU. The aim of the research, and the need to meet technical requirements relate to increasing the robustness and stability of the AI DSS components. The robustness of airborne multi sensor imagery acquisition sub-system of existing AI DSS are increased by replacing of the existing acquisition (desktop) computer with the industrial (computer) controller, which will have the task of servicing up to two devices (rather than five, as previously). Two more industrial controllers are in the process of procurement. A desktop computer will be out of use in this way and the robustness of T-AI DSS will increase. Furthermore, the operational stability of the system for data collecting is increased by constructing and producing a new electric power supply for it. Power supply with automatic fuses / circuit breakers for switching individual equipment groups provides power from its own resources (battery power) without external converter for measuring equipment, monitors and laptops.

A study on the possibility of setting up and using the system for aerial hyperspectral data acquisition on the blimp was carried out. Smaller system for aerial data collection (due to the small payload capacity of the blimpn, figure 1a and 1b) is designed and constructed for this purpose. The study and test flights proved that airship is suitable for airborne hyperspectral survey for T-AI DSS purposes.

a

b

Figure 1. a) Small system for aerial hyperspectral data acquisition b) on the blimp (in green elipse).

Hardware and software limitation of capacity and functionalities for parametric georeferencing of the hyperspectral (cubes) data [Ivelja, Bajic, 2011] are solved by purchasing and using the new version of software and stronger processor in computer with larger RAM. This technical advance has been crucial to the processing of field recordings from Padjene (exploding munitions depot) and for hyperspectral mine field assessment technology (the bio-chemical and hyperspectral analysis of the vegetation inside and outside of the minefields).

Further research is being continued in order to increase the robustness and stability of the system as planned, as well as to explore the possibility of installing the system to other types of platforms.

2.2. Methodological requirements

Methodological requirements were related to:

- developing the airborne hyper-spectral mine field assessment technology, that should be approved by research and validation,
- developing the general airborne hyperspectral survey of the area in and out the exploded ammunition storage as new functionality for T-AI DSS (for getting new indicator of mine presence (possibly),
- the interactive semi-automatic methods of the detection and extraction of the “'strong” indicators of the mine presence,
- advancement of data fusion within DSS sub-system of T-AI DSS (finding a new method),
- analytical assessment of data from MIS to obtain general and specific requirements for providing additional data of SHA,
- researching and developing of the operational calibration methods.

Air data collection was not originally planned for the first year of the project. However, additional activity: detecting the debris and UXOs resulting from explosion of ammunition depots (which was not included in the proposal but appeared as an opportunity to improve AI DSS) has changed the plan and priorities for the first year of the project. The work on this task has been a major priority for CTDT and FGUNIZ in 2012, so the work on most methodological requirements will start in the second year of the project TIRAMISU.

In order to use multisensory system in its full potential, it is necessary to determine its limits. For that purpose, the target (figure 2.), according to ISO 12233, has been designed. Modulation transfer function (MTF) modeling through slanted-edge analysis is used. The potential of deriving MTF from slant-edge gives opportunity to use this function not only on target, but also on natural objects which have characteristics that have good definition of edge with at least 5% of slant.

Figure 2. Slant edge target and target with a pair of black and white lines of decreasing width values for MTF.

2.3. Other requirements

Other requirements were related to: advancement in the triage and the pre-processing of the acquired multisensor images, projection problems (different input data in different projections), developing of simplified version of the T-AI DSS (without the airborne multisensor acquisition and satellite images, only with MIS data), the trainings of the MAC surveyors (analytical assessment and obtaining of general and specific requirements) and the operators for the airborne multisensor acquisition.

In this sense, so far, the progress has been made in the triage of collecting images and applied on images of destroyed ammunition depot in Padjene. The new application that allows automatic geo-tagging images of MS4100 multispectral camera was used. It was not possible until then. Furthermore, training of two new operators during the airborne acquisition of multispectral images of explosion of ammunition depots was carried out.

3. Conclusion

T-AI DSS will benefit from the development of its components in TIRAMISU to fill gaps that were identified by the end-users and system operators , interpreters and user. The objectives include increasing its robustness, decreasing the workload of the operator and improving the semi-automatic mapping of features of interest. T-AI DSS is a solution that will be proposed to the MACs worldwide for specific terrain and actions. A simplified version (without data acquisition) will also be developed that can be used in MACs for the support of the SHA assessment, reduction, re-categorizing and inclusion, only with indicators of mine presence and mine absence derived from MIS data. Services will be provided to ensure transfer of know-how and capacity building. T-AI-DSS will also focus on the problems generated by the possible explosion of ammunition depots**.**

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