Retrieval of ISR Data for Image Interpretation Exercises

Bela Andreas Bargel and Wolfgang Roller

***Abstract*—Image interpretation (e.g. for image-based radar, infrared, electro-optical) is a complex task in context of Intelligence, Surveillance and Reconnaissance (ISR). To support and enhance education and training of image interpreters operation-related reconnaissance data is advantageous and important. In this paper a concept of a semi-automatic generation of image interpretation exercises is presented by using data based on NATO standardization agreements (STANAG). The novel approach thereby is to utilize these different mission-requirements-based data formats effectively within the context of technology-enhanced learning by creating web-based exercises for online usage and presentation slides for classroom lessons.**

***Index Terms*—e-learning, knowledge retrieval, ISR, STANAG, CSD**

I. Introduction

Intelligence, Surveillance and Reconnaissance systems (ISR) provide a huge amount of different types of images like electro-optical (EO), infrared (IR) and furthermore Synthetic Aperture Radar (SAR). Combined with exploitation reports this data might also provide high potential value for instruction and training scenarios [1], especially when using data from multiple sensors within the same network (Fig. 1). As the structure of ISR reports fit the demands of operation (NATO standard agreement, STANAG) and have not been designed with training purposes in mind, it has to be investigated whether common reporting formats can be utilized to serve as data provider for learning scenarios.

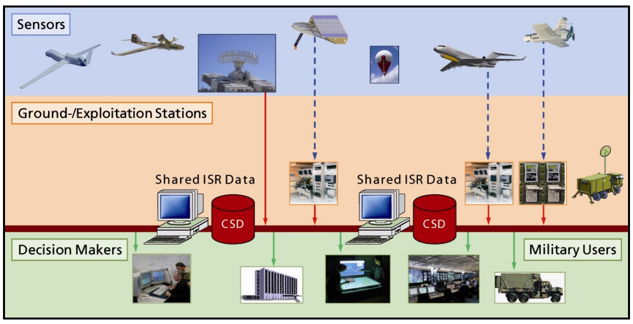

Fig. 1. Information sharing using coalition shared data (CSD) server

In context of our work it is envisaged to general underpin the training of image interpreters especially when working with different reference material from different sensors. In particular radar images differ considerably from that of optical images due to system inherent effects like foreshortening and layover. Otherwise the electromagnetic waves used by SAR are capable of capturing images in unfavourable conditions as night and fog and displaying them in such a way that they can be interpreted.

While image interpretation can be supported by a wide variety of tools, e.g. for image processing and image fusion [2], annotation, decision support [3], context-aware retrieval of help and learning units [4], and reporting [5], the human-factor in the interpretation process is essential for coherent and correct results. Therefore substantial training of image interpreters is necessary which also includes case studies and exercises for common sensor specific characteristics.

II. Approach

Beside proven training documents manually created over the years by instructors and experienced image interpreters also actual operation-related reconnaissance data is important and valuable. Therefore reliable data acquisition and preparation for training purposes according to learning objectives and teaching methodology have to be ensured. In case of SAR this process is supported by the technology-enhanced learning system SAR-Tutor [6] in a blended learning concept and will be further enhanced by (semi-) automatic generation of image interpretation exercises using mission-acquired data. Due to the task-oriented approach this data might also contain contradictions, maybe even a non-correct Ground Truth. Therefore the instructor is especially challenged to review the educational material generated by the system according to the intended learning objective (Fig. 2).

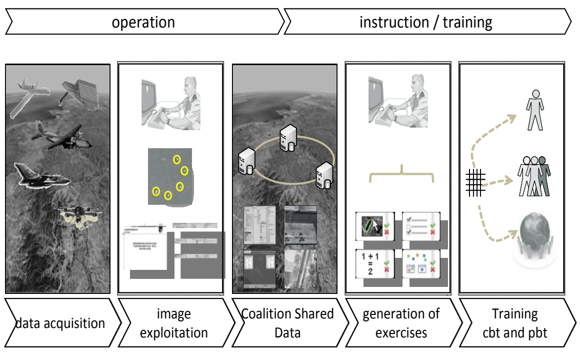

Fig. 2. Concept of using coalition shared data for technology enhanced learning

By the approach of standardization and interoperability undertaken by the NATO Standardization Agency (NSA) [7] and projects like MAJIIC[1] (Multi-Sensor Aerospace-Ground Joint ISR Interoperability Coalition) [8], MAJIIC2 (Multi-intelligence All-source Joint ISR Interoperability

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Coalition) and the development of Coalition Shared Data (CSD) servers [9] different kind of image data (STANAG 4545 [10]), video data (STANAG 4609 [11]) and reports (STANAG 3377/3596 [12]) are stored and accessible in a documented way and can be furthermore accompanied by mission task descriptions.

This triple of task, image and report is now used to generate education material. Users of the system (e.g. instructors) are enabled to query the system using a web browser and generating e-learning exercises or offline training material like a set of presentation slides on demand.

III. Generation of E-Learning Exercises

The results of a STANAG compliant image interpretation is stored inside a report, e.g. created using the reporting tool “Interactive ISR Exploitation Report”, i2exrep [5] (Fig. 3, left). STANAG 3596 describes 19 categories and each category as root element is followed by several main items which are followed by further items to raise the level of detail (*instance*). Main items include location and type, status, equipment and activity, defence, facilities, and damage assessment. Main items to be assigned vary from the purpose of the image interpretation (*purpose code*). A simplified hierarchy tree of category 1 airfields is shown in Fig. 3, right.

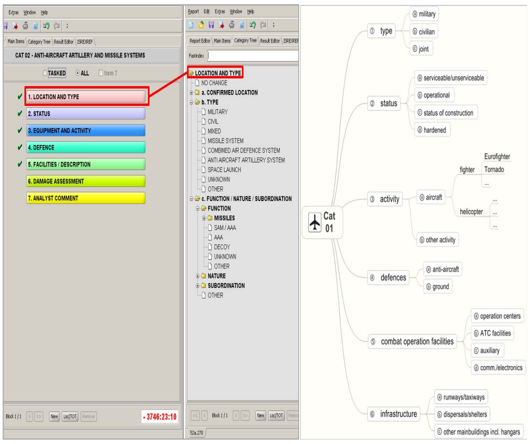

Fig. 3. Screenshots of i2exrep (left), simplified hierarchy of category 1 (right)

The data storage and dissemination inside the CSD-network is XML based. Therefore the reports can be parsed using common XML transformation frameworks. In our implementation we utilize the web framework Apache Cocoon [13], which itself is Spring [14] based. The content of the reports is structured following the “Air Reconnaissance Requesting and target reporting guide” [12] offering semi-structured content (*macro-level*) and including free text options. This hierarchy and information can be used while creating computer-based exercises. The stored XML-data is parsed and the information is used to generate computer-based exercises like multiple choice (multi select, single select), hotspot or cloze. For example (Fig. 4) this allows creation of a hotspot exercise asking for coordinates of a ‘general facility’ like a sports field as long as the report contains the information in latitude and longitude, or a multiple choice exercise for a type of building while showing the correct as one answer option (retrieved from the report) and presenting close by answer options retrieved also from STANAG 3596 items as distractors using the same hierarchical level within a category item.

The question itself can be formed using standard interrogation sentences extended by gaps (as cloze) which are filled by the information within the report. On the one hand this allows retrieval of usable metadata and image interpretation results, on the other hand a XML-transformation to create HTML-based exercises or transformation into formats like Sharable Content Object Reference Model (SCORM) [15] or IMS Question & Test Interoperability Specification (QTI) [16] for learning management systems (LMS).

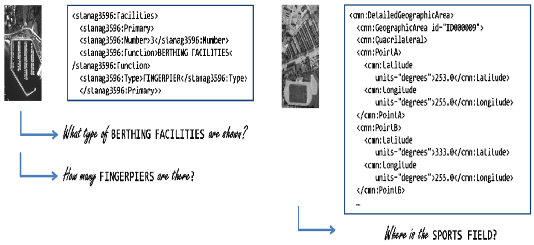

Fig. 4. Basic examples of exercises, optical image and corresponding report extracts

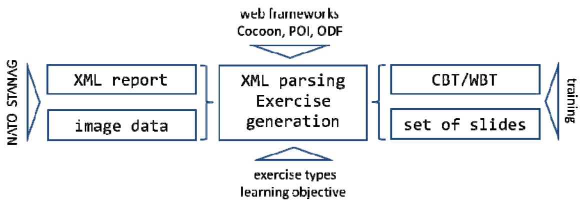

Fig. 5. Workflow for generation of e-learning exercises

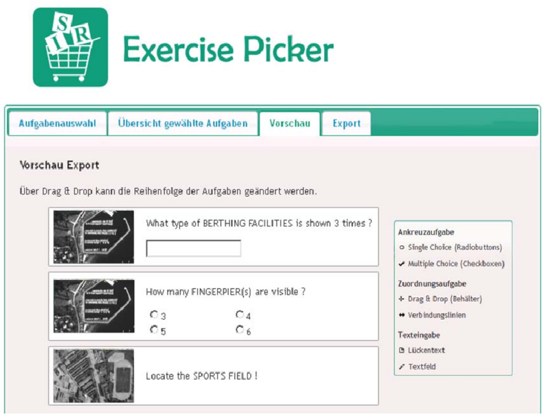

Fig. 6. Screenshot of “ISR exercise picker”

As modern ‘office formats’ are often XML based (Office Open XML, ISO/IEC 29500 and OpenDocument, ISO/IEC 26300:2006) transformation and export of exercises into a set of presentation slides for classroom usage is also feasible. While this transformation was initially also planned using Apache Cocoon, the integration of the Java API Apache POI (for supporting proprietary ‘.ppt’-PowerPoint) and Apache Simple Java API for ODF (supporting OpenDocument [17]) was simpler and more powerful to realize. Using Apache Simple ODF (currently ‘incubating’ [18]) for example allows easy usage of advanced options like writing the solution of an exercise as textual information in the comments area of the corresponding slide as background information for the tutor. In Fig. 5 the schematic workflow and in Fig. 6 a screenshot of our web-based “ISR Exercise Picker” prototype is shown.

IV. Outlook and Further Work

For simplification we used JPG-based images within our prototype. As mission-acquired ISR-image data is standardized using the NSIF format [19] a transformation into learning management system compatible image formats is necessary. Common converter like the Geospatial Data Abstraction Library (GDAL) [20] should be evaluated in further work.

Beside basic exercises also combined exercises can be composed. Furthermore the free text elements of a report can be taken into account. Reinert *et al.* [21] showed how to retrieve the free text information of reconnaissance reports using the open source natural language processing framework GATE [22] which might be used in a further step to include these free text annotations within the report for the generation of e-learning exercises.

In our work we successfully demonstrated retrieval and transformation of mission-acquired ISR data into useful sets of exercises in context of technology-enhanced learning for image interpreters. Exercise types include multiple choice (single select and multi select), simple cloze and hotspot. Furthermore the extension of simple cloze exercise to semantically-enriched cloze [23] is already predestined as the hierarchy of the “Air Reconnaissance Requesting and target reporting guide” can be interpreted as structure for close by answer options and can further be extended by synonyms outside the technical terminology of ISR. These results establish a basis for the development of an ISR client to query CSD networks for enabling instructors to create image interpretation exercises according to their didactical motivation. As the data might also contain contradictions we suggest a semi-automatic generation of such exercises: The instructor will query the system and review the results, the system will than generate exercises according to the parameters defined by the instructor.

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