Cover Sheet

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Data Analyzer Software: a Knowledge System Supporting Coalition Partners Information Sharing

Abstract

As current and future operations integrate soldiers from multiple nations, information that supports short term and long term teaming is critical. Among coalition forces, it is important to maintain unity of effort, to plan concurrently, and to make adjustment in sync, ensuring operations are carried out successfully. Combatant commanders have many responsibilities including ensuring the capability and capacity of the forces with partnering nations. However, in multinational operations there is the added need to consider differences in organizations, doctrines, terminologies, and objectives. This can be achieved through knowledge capturing, information sharing, and training. Additionally, giving commanders required information with explanation, linking knowledge and uncertainty could improve teamed operations in complex and dynamic environments. The Data Analyzer is an adaption of training software previously developed at the Army Research Laboratory. Now that this training software is being used by coalition partners and the US the Data Analyzer has been expanded as a platform for knowledge capturing and information sharing. The Data Analyzer provides commanders with the ability to view detailed experiential knowledge and find trends in tactics, techniques and procedures (TTPs) employed within coalition partners. This information from the analyzer provides the coalition forces with highlighted similarities and differences that aid in coalition engagement preparation and insights into actions that can impact coalition mission TTPs. We present the Data Analyzer software and illustrations utilizing this approach in supporting knowledge capturing and information sharing for multinational operations.

1 - Introduction

"Multinational operations are operations conducted by forces of two or more nations…"[1]. These coalitions are formed for humanitarian aid and disaster relief, as well as, military actions against perceived threats. For these types of partnerships to be successful "unity of effort", knowledge between partners and clear mission goals are some of the required elements. Interoperability between nations and standardization increase effective coalition operations. For coalition operations, information must be coordinated to fully understand tactics, integrate and synchronize missions, transfer and disseminate intelligence. Since these types of operations can have multiple chain of commands, decision making considerations must take into account the overall mission, the operational environment, size of the force, risk, duration and rules of engagement. In coalition engagements each country's regulations mandate when, where, and

how information is shared. For military coalitions, "effective information sharing enables the DoD to achieve dynamic situational awareness and enhance decision making to promote unity of effort across the Department and with external partners [2]."

Taking a more military view, information sharing is "the willingness to provide others with information [3]" particularly incorporating information provided from experienced soldiers or experts. Commanders use information sharing to "enhance their ability to execute battle commands [2]." Using common technology coalition partners may be able to increase their effectiveness in sharing information. In this case, the goal of any technology is to "provide a common understanding of a shared vision, mission and governing principle." The Applied Anomaly Detection Tool (AADT) and AADT Data Analyzer (DA) is a software system that aides in achieving this goal.

In the next section of this paper, we will present the AADT and AADT DA as an information capturing and information sharing software system that can be used by military coalitions and teams for training, situational awareness, and mission planning/reviewing as well as decision making. In section 4 we describe using AADT and AADT DA for information sharing among coalition commanders. In section 5 we describe using AADT and AADT DA for information sharing among partners' units. In section 6 we describe how AADT and AADT addresses information sharing challenges. In section 7 we briefly describe future work.

3 – AADT and AADT DA

The AADT Data Analyzer is an application that was originally developed to organize and present the data collected by the AADT. AADT is a software program designed for testing and training soldiers in finding targets and areas of interests in military relevant operations. In previous studies conducted at Army Research Laboratory, targets and areas of interest were referred to in general as anomalies. Soldiers often described key indicators of potential threats as anomalies and this terminology was adopted during the development of the AADT software. The AADT software has two subsystems, one for the trainer and one for the trainee. The trainer subsystem is used to create courses and classes. It is also used to configure the ordering of subject matter expert (SME) feedback, to set access control of courses created by the trainer, and to manage trainee evaluations. The trainer subsystem gives the trainer the ability to generate and modify the content of material that can be used to create a course. The trainee subsystem is the component of the AADT that allows a class to be taken. The trainee subsystem shows background information, interactive training or testing modules, SME feedback, quizzes, and evaluations. Since the primary use of AADT is for visual search and detection, a series of images are displayed by the software of different targets at various distances, in various terrains and environments. With the ability to present SME feedback, expert knowledge and instructional guidance is provided. The training AADT enhances the situational awareness or the understanding of the operation battlespace.

4 - Using AADT and AADT DA for information sharing among coalition commanders

In the AADT software commanders from the different coalition partners, as well as across teams, can use the trainer subsystem to generate a series of modules to share information related to key concepts for missions or tasks, particularly for those involving visual search of potential adversarial environments. There are many features for creating, modifying, and organizing basic background information and scenario driven modules. The primary feature is the anomaly page option. Anomaly pages are used to upload any image (single view, multi-view, or panoramic) from any type of sensor. Individual or groups of commanders can then draw polygons on the image where anomalies are located. To standardize the type of anomaly (target and AOI), the type is selected from a menu in the interface of pre-defined types. After selecting the type, a dialog box allows metadata to be added further describing the anomaly shown in the polygon. These descriptions are called key feedback. These are unique for each polygon type selected. As previously mentioned, AADT provides a robust set of pre-defined types and properties that can describe a wide variety of anomalies. However, new ones can be added by selecting 'Add New' option from the drop-down lists and entering the additional information. The key feedback information can be copied to an image feedback area. The Image Feedback area allows commanders to provide additional information about the image. This additional information can be a discussion of the overall scenario represented by the image or by categories of items. The highlighted items can be grouped by polygon types and the additional information can be organized to match these categories. The purpose of this feedback is to annotate why the individual anomalies are important to understanding the situations the image represents. The images can be grouped in modules by a designated theme, site, target type, or mission route.

The AADT DA interface has several features that support information sharing at the commander level. In the 'View' option a single image or a collection of images with anomalies highlighted and feedback for review (Figure 1). Figure 1 shows image feedback which is a general description of the scene and key feedback which gives general descriptions of the AOIs highlighted with black polygons. Having this capability allows the methodologies used by the different forces for identifying potential threats and assessing the critical components of the environment that may call for heightened situational awareness.
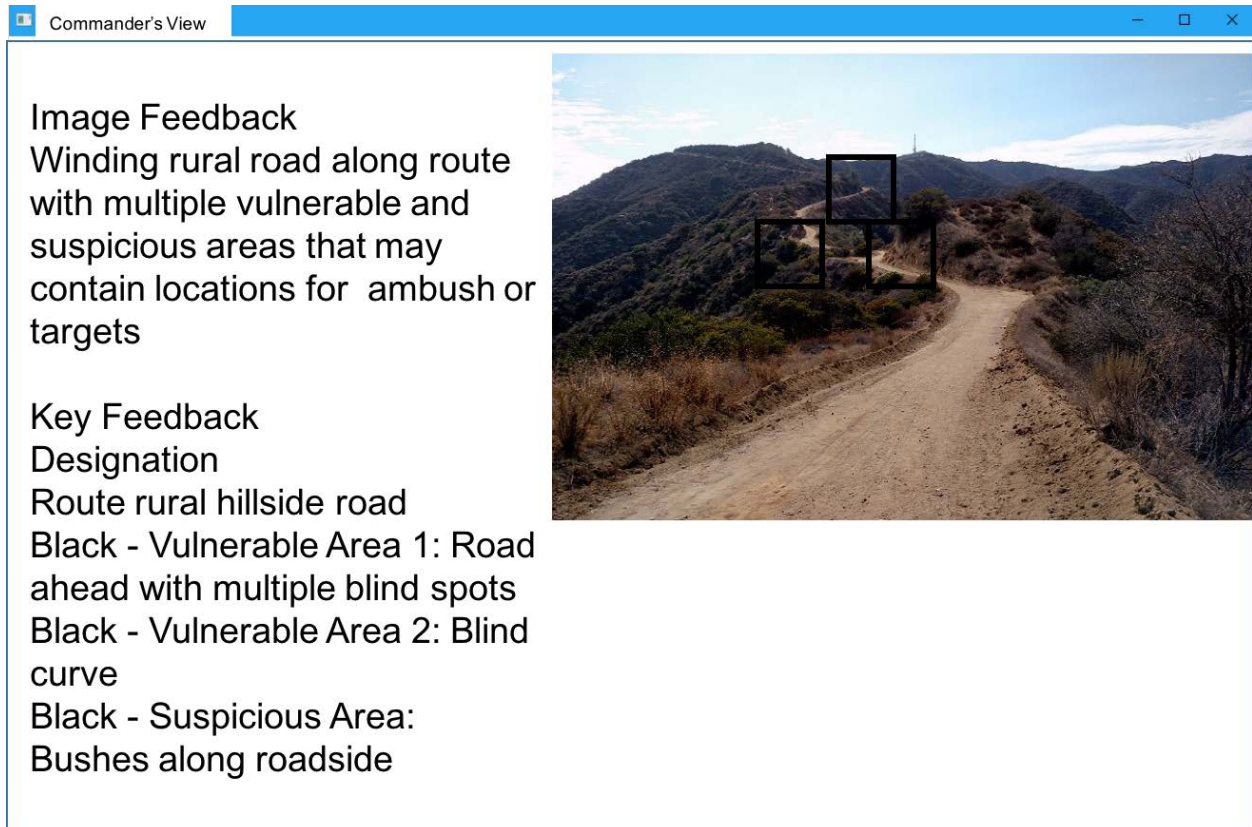
Figure 1. 'View' option of AADT DA

In addition, AADT allows commanders' and soldiers' demographic information to be recorded and analyzed in AADT DA as 'Demographics' *(*Figure 2). Multiple entries can be viewed and accessed. This information aide in understanding the background of the partners, and how their information is shaped by the doctrine and practices set by their country's policies. Sharing this information can indicate strengths and challenges within the specific tasks by the partners. This can facilitate modification in assignments or actions that can improve unit level dynamics, increasing mission success.

Demographics	
ID Number: 7001	**Age:** 26-35
Number of Years in Service: 0-5	**MOS Primary Code:** 68W
Military Rank/Grade: PVT	**MOS Primary Job Title:** 68W10
Land Navigation Qualifications?: Yes	**MOS Secondary Code:** None
Weapons Qualifications: Marksman	**MOS Secondary Job Title:** None
List Additional Weapons: NA	**MOS Time (in years):** 0-5
Fluent Languages (exclude English): NA	**Have you ever been deployed?:** No

Figure 2. Demographic information

5 - Using AADT and AADT DA for information sharing among partners' units

After commanders use AADT and AADT DA to create and review modules related to various aspects of the operation then sharing that information at the unit levels can be done in several ways supporting training and missions. The motivation for commanders using AADT DA for information sharing include 1) enhanced dissemination of tactics, techniques and procedures (TTPs) that have been agreed upon for an event, 2) enhanced situational understanding of the battlespace across coalition partners, and 3) presentation of a unified view of the factors that influence the decisions by the coalition forces. Military planning is complex and varies in form and scope, and significant training is conducted in preparation prior to any military operation. The rationale is that after training the performance of the unit can be shared at the commander level to ensure commonality of level of preparedness across coalition partners. The same material can be used as a part of the mission planning where details of potential threats and vulnerabilities can be discussed. In [4] a detailed description of AADT is given. In this section, we will discuss how AADT DA can be used for information sharing to support training/mission planning.

The same modules that the commanders used to share information in the previous section (visual search task) can be adapted as training modules and integrated into a course to be administered to the soldiers within the coalition units. Data from individual soldiers in a unit collected from the training using the AADT can be viewed directly in the AADT DA software. This performance data collected provides the number of correct anomalies (targets and areas of interest) detected by the soldiers as progress through the module(s) is made. At its most basic, this information can be consolidated to give a score indicating correct detections, which can be reviewed and assessed for one soldier or groups of soldiers. For example, if there are soldiers within the units that have similar MOSs and carry out similar tasks, AADT DA can be used by the commanders to verify that these soldiers have a level of proficiency that will allow them to work efficiently as a team. AADT DA allows the commanders to view the information within the course(s) allowing for effortless comparisons between the performance data and ensures the integrity of data analysis. By providing this information to commanders prior to execution of a mission, gaps within preparation, whether low overall scores or low scores for a particular scenario can be addressed. Information can then be shared across the commanders safeguarding their soldiers by allowing further training or clarification of objectives. AADT DA also displays detailed statistics about keywords used in the feedback, and how these terms are used across the coalition partners and teams. In addition, the statistics show how the terms are connected to types and categories of the anomalies allowing for generation of a common lexicon and review verifying consistency in key terminology used by the coalition partners and teams. AADT DA displays detailed information about where and the sequence in which the anomalies are selected by the soldiers. This gives commanders the opportunity to confirm that the soldiers are coordinated with identifying primary threats in the operation environment. The data analyzer displays the images with the polygons and feedback created by the commanders with the corresponding highlights providing dissemination of knowledge both expert and intelligence that is useful for the task. Additionally, the data analyzer can display data from multiple soldiers at once for given image(s), which may indicate trends and patterns. This is done by using the 'Click Clustering' option shown in Figure 3. With this option, the image or images can be viewed with the marks to show where soldiers have detected potential targets or threats. Clustering of these marks can reveal common areas of vulnerabilities recognized by soldiers from the coalition forces. The clustering can also reveal vulnerabilities that soldiers from one country observes and not the other. By sharing this information a commander may be able to leverage how a partnering country's force identify possible threats and implement that strategy for the combined effort improving mission success.

Figure 3. 'Click Clustering' Option

6 – AADT and AADT DA Addressing Information Sharing Challenges

Information (knowledge) is the most important capital of current organizations and key to gaining a strategic advantage [5]. How information is obtained, stored/organized and more so how information is accessed/shared are vital considerations. In highly turbulent environments, such as military operations, information is needed even more in mission-critical situations [6]. In 2003, the US developed Blue Force Tracker to display the locations of friendly forces reducing the number of casualties. The UK enabled commanders to compile information from multiple sources allowing redirection of troops' movement to avoid evolving threats. These are examples of how individual countries have strengthened their capabilities by sharing information within their organizations [7]. Thus, sharing information "has become more significant as countries join together". There continues to be a need for automated capabilities for sharing command and control information and situational awareness information between nations [8]. The AADT and ADDT DA addresses this challenge, specifically for the identification of visual cues of potential targets and AOI for enhanced situational awareness and implications on decision making. AADT DA allows images and videos of the scenes to be viewed, reviewed with annotations, and

analyzed with expert (commanders and unit leaders) feedback from multiple sources (i.e., coalition partners). The AADT DA can be used to share information for training soldiers across coalition partners prior to missions. This gives commanders the capability of reviewing and understanding individual TTPs as well as leveraging information and perspectives from each other. It also allows the opportunity to synchronize any differences in training so that partners are on the similar pages as they equip their soldiers for engagements. The AADT DA can be used to conduct mission planning and mission reviews allowing coalition partners the ability confirm decisions for actions taken based on viewing information that is a consolidation to their individual TTPs. This also allows them to review how this information influenced the success of the mission and modify information to improve situational awareness across the coalition operation. These capabilities allow coalitions to share information supporting enhanced situational awareness that represents a more common view and assessment of the battlefield.

7 – Future work

The primary use of AADT and AADT DA has been for training but now the software is being expanded to support other areas of research. Leaders must employ both commonsense and expert knowledge when assessing threats and understanding the battlefield from visual evidence. In the future automated systems will be integrated into these coalitions. Information will then need to be shared by both leaders and automated systems. In this application, several assumptions are made including those related to security and networking. Therefore, future research that addresses the challenges such as ensuring security levels are appropriate while maximizing sharing between coalitions will provide solutions for advance interactive knowledge capture, annotating, and sharing information building on AADT and AADT DA.

8– References

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