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A Human Factors Analysis of Aided Target Recognition Technology

by Bruce S. Sterling and Catherine N. Jacobson

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14. ABSTRACT

We conducted a study to address three research objectives: (1) to determine how the use of a specific aided target recognition (AiTR) system affected scout workload, stress, and performance; (2) to examine Soldier-system interface issues; (3) to determine tactics, techniques, and procedures (TTPs) for using AiTR. We found that overall workload, stress, and performance with AiTR were acceptable, although subject matter expert ratings of scout performance may have been lenient because of the scouts' lack of experience with AiTR. Workload and stress tended to be higher in an airport surveillance scenario, perhaps because of the complexity of the situation and the amount of territory to survey. Workload and stress are higher at night, perhaps because with differences in day and night thermal imagery, structures and terrain features are represented differently, depending on light conditions, so that cues normally used in daylight imagery may be altered or not available in night imagery. However, with more experience with thermal imagery at night, stress levels may decrease. Workload and stress tended to be higher when AiTR was used intermittently, perhaps because of constant switching between modes and the effects of re-esablishing situational awareness, based on the features of each mode (i.e., refamiliarizing oneself with image chips). Concerning performance, target detection was rated slightly better when the AiTR was not used, which perhaps reflected use of the stare mode when an observation post (OP) was initially occupied. Several specific recommendations were made for improving the interface, such as adding grid lines to the map. A few TTPs for using AiTR were identified, including the use of the stationary target indicator mode when an OP was occupied; then we switched to moving target indicator mode. Another TTP was using AiTR to detect targets (perhaps except when an OP was initially occupied) and then stare (manual) mode to identify them.

15. SUBJECT TERMS

aided target recognition; AiTR; human factors

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1. Introduction

1.1 Project Background

Future scouts will have many simultaneous tasks with which to contend. They will have to maintain overall situational awareness (SA) using a common operational picture, receive instructions from and provide information to higher headquarters, plan and adjust routes for manned and unmanned vehicles, monitor sensor locations, receive information from multiple sensors, synthesize that information and provide "target-able" data to those who need it, and maintain local SA.

Because the scout must perform several tasks simultaneously, sufficient time will not be available to simply focus on sensor imagery. Furthermore, the battle space of the scout may be complex, with many objects that could be interpreted as targets. Thus, effective aided target recognition (AiTR) technology is critical to reducing scout workload and enabling scouts to perform their jobs more effectively.

Several studies have demonstrated that AiTR improves target identification. McDowell (1992) showed that performance with AiTR was better than unaided performance when AiTR was 40% and 80% reliable. Similarly, Entin, Entin, and MacMillan (1994) demonstrated that AITR at 80% accuracy increased hits in target recognition compared to unaided target recognition without increasing false alarm rates. Kibbe and Weisgerber (1991) showed that AiTR of 70% and 90% accuracy improved target recognition in comparison to unaided performance, but AiTR of 50% accuracy did not.

The AiTR technology considered in this study is not simply the sensor and the algorithms used but the entire Soldier system interface. This includes controls such as a mouse, joystick, and buttons. It also includes displays that provide the Soldier with software menus, streaming imagery, digital maps, representations of targets on the terrain, and other features.

1.2 Research Objective

This research had three main objectives: (a) to determine how AiTR affects the workload, stress, and performance of scouts; (b) to determine improvements necessary for the Soldier-machine interface; (c) to determine the tactics, techniques, and procedures (TTPs) employed by scouts concerning the use of AiTR.

2. Method

2.1 Participants

Participants were seven experienced scouts (rank of Sergeant E5 or Major 04). The participants were recruited and trained in the use of the interface by subject matter experts (SMEs) working with the Night Vision and Electronic Sensors Directorate (NVESD) of the U.S. Army Research Laboratory (ARL) on this project. Since the interface involves only a few controls and functions, roughly 1 hour of training before the experiment was sufficient for test participants to be able to operate the system.

For a small sample size (n = 7), the span of age, time in service, rank and military experience was fairly large, from sergeants to majors, from Soldiers with 2 years of service to one Soldier with more than 20 years of military experience. The sample provided a nice cross section of Soldiers who did and did not wear corrective eyewear. There were, however, no left-handed Soldiers in this study. Two of the seven Soldiers were commissioned officers (major or 04) and the other five were sergeants (E5). One officer was from cavalry, while the other was from intelligence. Four of the sergeants were scouts (19D), and the fifth was armor (19K). The median age was 27 years with a median time in the Army of approximately 7 years, and time in military occupational specialty (or branch) of 7 years. All the Soldiers were right handed. Four (57%) did not use any corrective lenses, and three (43%) wore glasses. None was color blind. Five of the seven (71%) had experience using forward-looking infrared (FLIR) radar. Generally, the participants reported limited experience with using FLIR.

2.2 Instrumentation

2.2.1 Interface

The interface consisted of two computer screens, a joystick control unit, a mouse, and a keyboard, in the rear of a high mobility multipurpose wheeled vehicle (HMMWV). The computer screen to the right of the scout provided a digital map of the battle field and was referred to as the SA screen (see appendix A). The AiTR provided Soldiers with the ability to populate the SA screen with "lased[1]" targets. The computer screen directly in front of the scout, referred to as the crew station screen, provided all sensor feed imagery and was split into different sections; the top half showed a live view of a specific part of the terrain chosen by the scout when in "stare" mode or a selected static view from the gimbal scan mode, which was updated every 6 seconds. Symbols (color-coded brackets) for targets detected in the entire area that was selected for surveillance were displayed in three locations: (a) within the image chips described next, (b) in the top half of the

[1]That is, to emit coherent light at

screen where live and static imagery is displayed, and (c) in the panoramic view that is displayed at the bottom of the screen.

When AiTR is activated, as many as ten small pictures of potential targets (called chips) are displayed from left to right in reference to their locations in the top and bottom screens just described. Target reports coming from AiTR boxes have a confidence assigned to them by algorithms. The confidence comes from how target-like the detection is, based on measured features. The user can manually set a threshold of confidence for target detection. If the user sets a high threshold, few detections will be made and the likelihood of the detections being actual targets will be high. Conversely, if the user sets a low threshold, more detections will be made, but the chances of a detection being an actual target will be lower. When more than ten targets that meet the set threshold have been detected, the first detections disappear from the crew station screen. Within the AiTR mode, stationary target indication (STI) or moving target indication (MTI) can be selected. The STI mode elicits a higher rate of false positives (e.g., hot spots caused by roofs). The MTI mode is much more reliable and has a false alarm rate of one to two orders of magnitude below STI but will miss stationary targets. A scout can choose to use AiTR on a selected portion of an area so that, for example, a highway that contains much civilian traffic can be eliminated.

The joystick unit controls the movement and zoom function of the sensor in manual mode. Buttons on the joystick are also available on the screen and are manipulated via the mouse. These buttons control sensor gain (contrast), level (brightness), and polarity (white hot versus black hot), pan, focus, wide and narrow field of views, two electronic zooms, and manual control of the sensor. Appendix A provides illustrations of the crew station and the joystick control.

2.2.2 Demographic Questionnaire

A brief demographic questionnaire was administered to identify the relevant characteristics of the participants, such as length of service, experience in an operational environment, and experience with infrared imagery (see appendix B).

2.2.3 Workload

The Bedford Workload Scale (Roscoe, 1984) is a one-item, 10-point assessment of workload. Workload is first assessed on a three-part scale concerning whether it was possible to complete identified tasks and whether workload was tolerable or satisfactory. If it was not possible to complete the task, barring system breakdowns, the workload rating is recorded as 10, which indicates the highest workload level that can be reported. Degrees of tolerability or satisfaction (if applicable) are rated on behaviorally anchored scale points. The instrument is shown in appendix C.

2.2.4 Physiological Measure of Stress

Galvanic skin response (GSR) is a measure of the amount of electrical conductivity on the surface of the skin (usually fingers or palms), which is associated with sweat gland activity. It has long been considered a measure of physiological and mental stress (Fenz & Epstein, 1967). Although there are no absolute levels of GSR indicative of high workload or stress, GSR is a good relative indicator of stress; higher GSRs recorded during certain tasks suggest higher levels of stress. GSR data were collected with a SenseWear Pro2[2] armband. This is a wearable body monitor that enables continuous physiological data collection. It is worn on the back of the upper right arm and collects raw physiological data, including movement (used to calculate caloric data), heat flow, skin temperature, ambient temperature, and GSR.

2.2.5 Subjective Measure of Stress

One-item rating scales measuring physical stress and mental stress for selected tasks were also used (see appendix D).

2.2.6 Objective Performance Measures

We attempted to use several objective performance measures. One set of measures was to assess aspects of latency, such as time from when a target is in range to when it is first detected (i.e., labeled as an object of military significance), then classified (e.g., tracked versus wheeled vehicle), then recognized (e.g., tank versus armored personnel carrier), and then identified (e.g., M1A1 versus T-72). Another set of measures was to assess aspects of accuracy, such as the total number of targets presented to the Soldier versus the number of targets that the Soldier acquired (detected, classified, recognized, and identified). Position and heading (aspect) of the target were also to be collected from participants, although "ground truth" (i.e., the actual location of the objects) for these aspects was not available from the instrumentation until the next day. These performance measures were to be collected by a verbal spot report provided by participants (via radio) to the platoon leader whenever targets are acquired. The time of acquisition and the degree of specificity that Soldiers were to provide for acquisitions were to be recorded and used to assess latency and accuracy of performance. The platoon leader was aware of ground truth concerning the targets (type and location) and the time they first were able to be detected (i.e., when they were emplaced on the battle field). Range and heading ground truth were available the next day. The data collection form for these measures is in appendix E.

Serious problems arose in the collection of objective performance data. The most serious was that, despite instructions, Soldiers did not always report a target when they saw one, and report quality varied so that time of target detection, classification, recognition, and identification could not be measured. There were potential confounds, such as scouts using dust clouds to detect moving targets (although that strategy is not foolproof, since wind could stir dust clouds). We

[2]SenseWear Pro2 is a trademark of BodyMedia.

were able to collect some objective performance data, however. For scenarios in which targets were moving toward the participant, we collected distance from the participant when the target was reported (detected). For scenarios in which the target was a fixed range from the participant, we recorded whether the target was detected.

2.2.7 Subjective Performance Measures

Because of problems encountered in previous field research related to future sensor technologies collecting ground truth data, a more qualitative approach to measuring performance was used. The SME observer was also asked to rate scouts for their ability to acquire targets during the different conditions (scenarios, time of day, and use of AiTR). A SME questionnaire is presented in appendix F.

2.2.8 Questionnaire

A questionnaire was administered to assess the Soldier-machine interface in terms of controls, displays, various modes of employment (e.g., gimbal or automatic search mode versus stare or scout-directed mode), and other similar aspects. See appendix G for a copy of the questionnaire.

2.2.9 Interview

An interview was conducted to further assess the Soldier-machine interface (i.e., address control and display issues) and to reveal insights into TTPs that will best serve the Soldier in effectively using AiTR technology (e.g., when do scouts use gimbal versus stare mode, and when do they use AiTR versus manual mode). See appendix H for a copy of the interview structure and content.

2.2.10 Observations

Experimenters were able to view the user displays during portions of the scenarios through video monitoring and to make observations concerning qualitative assessments of scout performance in acquiring targets, the Soldier-system interface (e.g., difficulties using controls and displays), and TTPs used by the Soldiers (e.g., when gimbal versus stare mode is used). Intermittently, experimenters also remotely observed the scouts from a side view as they interacted with the AiTR controls and displays.

2.3 Procedure

The demonstration itself was organized, conducted, and controlled by NVESD. The only responsibility of ARL concerning this demonstration was the collection of data as described in this report. As described in appendix I, the study involved five scenarios, including but not limited to watching for suspicious activity along a highway, watching for suspicious activity around an airport (reflects military operations in urban terrain or MOUT), observing activity at

an Army installation gate (reflects a check point), observing activity along a "border" (reflects border patrol military operations), and observing open terrain. The scenarios occurred during the day and at night. Soldiers could choose to use or not use the AiTR during the scenarios. In a field test, however, it was not possible to counterbalance the use of AiTR, scenario, and time of day for all scenarios. An example of an attempt at counter-balancing is given in table 1.

Table 1. Counterbalanced scenarios and daylight conditions.

Day	Night	Day	Night	Day	Night
Highway	Airport	Checkpoint	Border	Open Terrain	Other
Airport	Checkpoint	Border	Open Terrain	Other	Highway
Checkpoint	Border	Open Terrain	Other	Highway	Airport
Border	Open Terrain	Other	Highway	Airport	Checkpoint
Open Terrain	Other	Highway	Airport	Checkpoint	Border
Other	Highway	Airport	Checkpoint	Border	Open Terrain

Data about workload, stress, and performance, as well as observations, were collected multiple times during each scenario (day, night, AiTR activated, AiTR de-activated). Performance data were not collected continually because targets in open terrain were moving in and out of view. It was unrealistic to expect scouts to report every time they re-acquired a target. Questionnaires were administered and interviews were conducted at the end of the study.

2.4 Analysis

2.4.1 Independent Variables

The independent variables include (a) scenario (highway, airport, checkpoint, border, open terrain), (b) time of day (limited day, night), and (c) use of AiTR. Although scenarios are defined and treated as separate conditions, some scenarios share many of the same features. For example, the border scenario contains features of open terrain as well as gate surveillance. In particular, the scenarios for gate, airport, open and border contain many of the same features, although analysis and discussion are based on the treatment of the scenarios as separate conditions. Because of range availability, the tests began about 2 hours before sunset. Transition to thermal sensors began well before sunset. The use of AiTR was not a true independent variable, since scouts were free to determine when to use AiTR and because of the variability in AiTR performance. It was necessary to allow participants to choose when to use AiTR since when and how scouts use AiTR was an important TTP to be learned from the demonstration. However, the relationship between the use of AiTR and performance was examined in a correlational manner. That is, objective and subjective performance measures were compared when AiTR was on, off, and used intermittently.

2.4.2 Dependent Variables

The dependent variables include (a) workload, (b) stress (as measured by GSR), (c) performance (accuracy, range), (d) Soldier response to the Soldier-system interface (via questionnaire,

interview and observations), and (e) Soldier response to the development of TTPs for using the tools available (via interview and observations).

2.4.3 Statistical Analysis

Means for the dependent variables of workload, stress, performance, and observations are reported for the various conditions of each scenario (time of day and use of AiTR). Because of the restrictions of the design, however, no inferential statistics are used. Questionnaire data report averages for Soldier responses to each item, and interview data are summarized and presented according to emerging themes. Table 2 lists the data collection instruments that were used to answer the three objectives of this study.

Table 2. Data by objective.

	Objective 1 **Soldier workload, stress, and performance**	**Objective 2** **Soldier-system interface**	**Objective 3** **TTPs**
Data Source	• Workload (Bedford Workload Scale) • Stress (GSR via armbands; subjective) • Performance (objective measures of latency and accuracy; subjective) • Observations	• Questionnaire • Interview • Observations	• Interview • Observations

3. Method

3.1 Objective 1: Soldier Workload, Stress, and Performance

3.1.1 Workload

Table 3 presents Soldier workload by scenario. Overall, workload was relatively low for all tasks and all scenarios (about two to three on a ten-point scale). Of the scenarios that had a valid number of observations, airport surveillance seemed to have the highest workload over all tasks compared to other scenarios. Also, airport-border surveillance had a higher workload for detecting targets. Higher workload during airport surveillance may be attributed to the complexity of the environment and the increased activity present. Soldiers monitored activity around structures, fencing, gates, spaces between structures, as well as rolling land surrounding the airport. Activity in this scenario included air traffic, vehicle traffic, some foot traffic, and additional traffic in the distance (unrelated vehicle testing at a distant test site). Soldiers not only monitored the space, all activity within the space, and AiTR hits, but they also continued to monitor AiTR hits that were already acknowledged. Several Soldiers commented on strategies to manage the workload associated with monitoring and tracking acknowledged AiTR hits. Additionally, some Soldiers suggested additional AiTR functionality that would be helpful in managing acknowledged AiTR hits.

Table 3. Mean workload rating by task by scensrio.

Scenario	n	Overall Workload	Detecting Targets	Manipulating Sensor in Stare Mode	Placing Targets on Map	Using Map Tools	Providing Verbal Spot Reports
Highway surveillance	7	2.0	2.3	1.9	1.3	1.3	1.7
Airport surveillance	7	3.4	3.1	3.1	2.4	2.6	2.1
Gate surveillance	1	2.0	2.0	3.0	3.0	3.0	2.0
Open terrain	12	2.6	2.3	2.4	2.3	2.2	1.9
Airport-border	4	2.3	3.5	2.3	2.0	2.0	1.8
Airport-open	1	2.0	4.0	2.0	2.0	2.0	2.0
Border-open	1	1.0	1.0	1.0	1.0	1.0	1.0
Overall mean	33	2.5	2.6	2.4	2.1	2.0	1.9

n = number of observations in that scenario

Table 4 shows workload data by time of day. Workload at night was somewhat higher and may be the result of only a thermal (night FLIR) signature being available for distinguishing targets. Furthermore, night conditions do not provide Soldiers with the same ground and terrain features that would otherwise be useful in maintaining SA and familiarity with their assigned area of surveillance. The difference in representation of terrain references may cause additional workload as Soldiers exert mental effort to incorporate new ways of establishing familiarity of their assigned area of reconnaissance. However, the Soldiers acting as scouts in this demonstration were relatively inexperienced with FLIR and AiTR. As scouts acquire more experience with both, they might learn to use night FLIR as well as day FLIR, thus reducing the discrepancy in stress levels between day and night conditions. Night runs extended late into the evening, which may have affected perceived workload if Soldiers did not receive adequate rest before arriving at the test site.

Table 4. Mean workload rating by task by time of day.

Time of Day	n	Overall Workload	Detecting Targets	Manipulating Sensor in Stare Mode	Placing Targets on Map	Using Map Tools	Providing Verbal Spot Reports
Limited day	10	2.3	2.4	2.3	1.9	1.9	2.0
Night	15	2.8	3.1	2.7	2.2	2.2	1.9
Combined	8	2.3	2.0	2.0	2.0	1.9	1.8
Overall mean	33	2.5	2.6	2.4	2.1	2.0	1.9

n = number of observations in that condition

Table 5 presents workload data by use of AiTR. It appears that intermittent use of AiTR results in somewhat higher overall workload for tasks involving surveillance and for detecting targets and manipulating the sensor. The workload for AiTR was slightly higher for tasks involving reporting (placing targets on map, using map tools, and verbal spot reports) and is likely the result of the functionality being available to Soldiers. It follows that workload when AiTR was not used is the lowest across all tasks, given the unavailability of features for the Soldier to employ. Not using AiTR seems to be associated with slightly lower workloads and may also be the result of Soldiers

not having to acknowledge, process, manage, and track the AiTR hits as they appeared when in AiTR mode. Perhaps intermittent use indicated that Soldiers kept switching between AiTR and manual mode in order to use the better method of detecting a target, thus confounding mode of use with difficulty of target identification.

Table 5. Mean workload rating by task by use of AiTR.

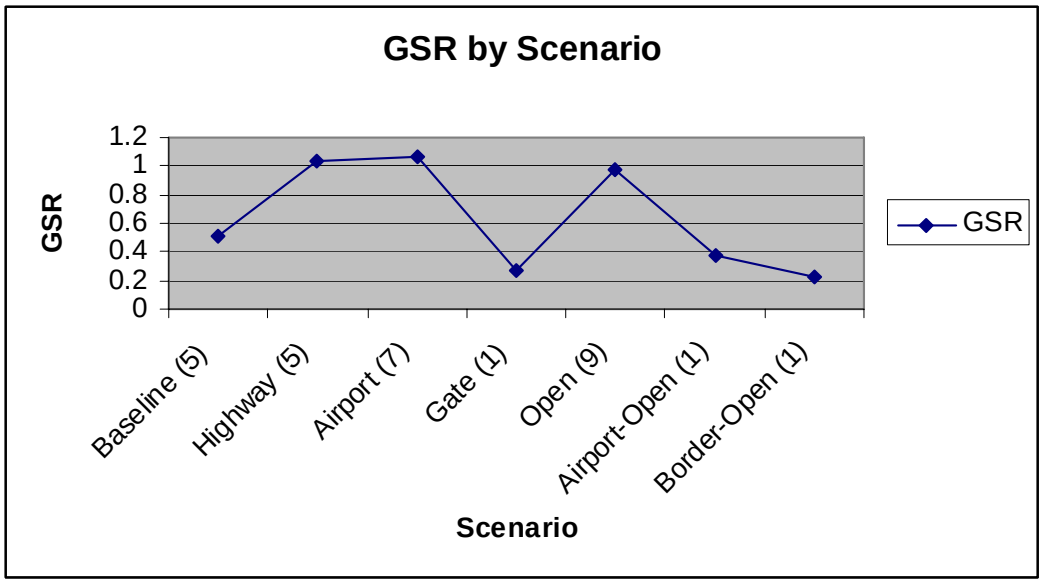
Use of AiTR	n	Overall Workload	Detecting Targets	Manipulating Sensor in Stare Mode	Placing Targets on Map	Using Map Tools	Providing Verbal Spot Reports
AiTR used	14	2.4	2.6	2.4	2.2	2.3	2.1
AiTR not used	4	2.0	2.5	1.8	1.0	1.0	1.5
Intermittent use	15	2.7	2.7	2.5	2.2	2.1	1.8
Overall mean	33	2.5	2.6	2.4	2.1	2.0	1.9

n = number of observations in that condition

3.1.2 Objective Measure of Stress

Figure 1 shows GSR by scenario. Compared to baseline GSR, measured when participants were resting, GSR during highway surveillance, airport surveillance, and open terrain scenarios was roughly twice as high. Thus, all three scenarios run most frequently appear to be more stressful than baseline (normal). Gate, airport-open and border-open scenarios do not contain a valid number of cases to provide substantial insight into why they report low GSR levels. The higher levels of GSR reported during highway and airport surveillance and during open terrain may reflect a busier environment for surveillance. Although higher levels of stress may be the result of generally more terrain and activity to observe and track during surveillance, they could also indicate shortfalls in the design of the AiTR interface so that the task of monitoring and tracking surveillance data (i.e., targets) cannot be accomplished by the Soldier without significant increases in workload and stress. For example, several test participants suggested revision of the AiTR interface so that additional data would be provided to the operator in order to reduce mental calculations involved in tracking acquired targets via AiTR. Several participants suggested that AiTR symbols should display the map grid so that Soldiers could more easily determine AiTR re-acquisitions. Suggestions for re-design of the display and added software features and functionalities suggest that the AiTR interface (and not simply the scope or complexity of the area of surveillance) may contribute to higher levels of stress.

Figure 2 shows GSR by time of day. Compared to baseline GSR, limited day is somewhat higher, but night is about twice as high as baseline. As mentioned previously, night conditions present challenges to the scout because surveillance is limited to what the thermal imagery depicts, thus no defining characteristics that might normally be seen during daylight, such as dust clouds, which may indicate vehicle movement, are available. Furthermore, terrain features cannot be used to assist in establishing familiarity with the assigned area of surveillance.



n = number of observations in that condition

Figure 1. GSR by scenario.

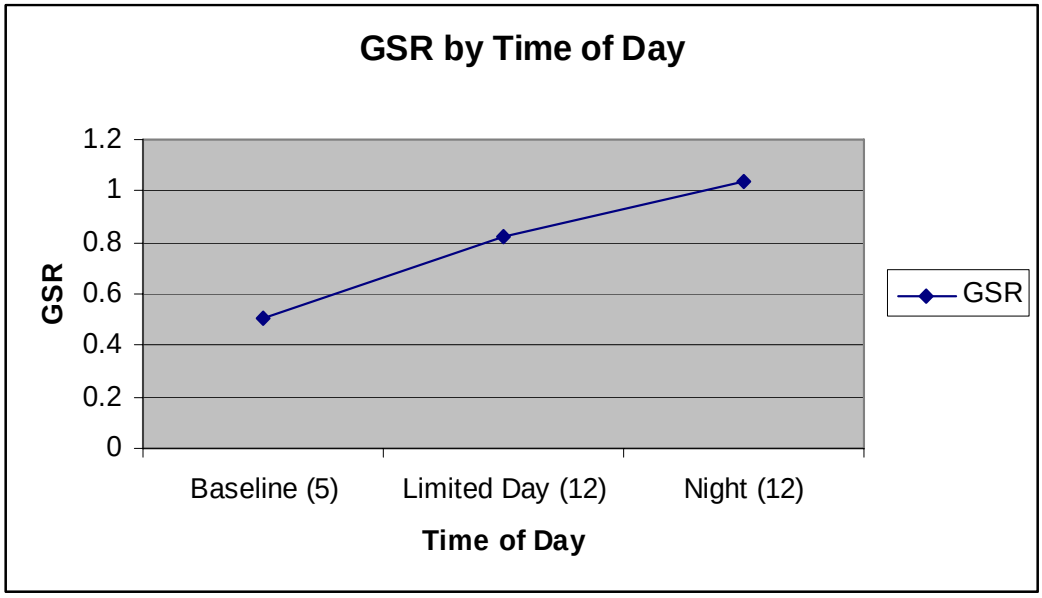


Figure 2. Mean GSR by time of day.

Figure 3 shows GSR by use of AiTR. The GSR during use of AiTR is comparable to baseline GSR. However, GSR when AiTR is not used or used intermittently is about twice as high as baseline. This suggests that not using AiTR is more stressful. Without the aid of AiTR, the scouts must rely on constant vigilance over an area of surveillance. All objects of interest must be processed, which includes a manual scan of the immediate area, use of brightness, contrast, polarity, and zoom to assist in the accomplishment of the steps for target recognition. Without the use of AiTR, the operator must note where all objects of interest are located in their area of

surveillance. Furthermore, with AiTR, the area of surveillance is relatively large. Without AiTR, the same area of surveillance may appear to be much larger when the aids provided with AiTR are not available.

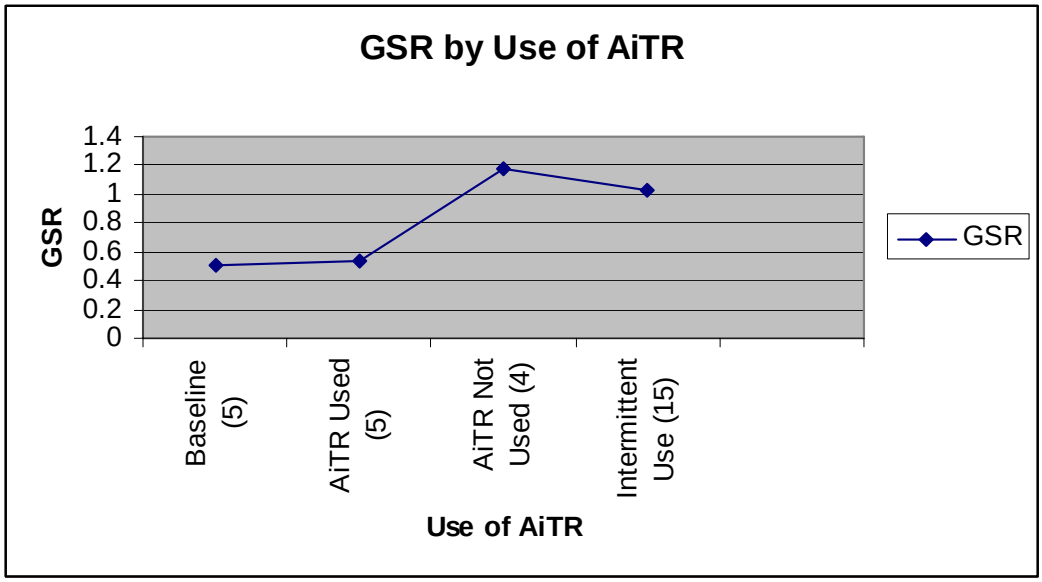


Figure 3. Mean GSR by use of AiTR.

3.1.3 Subjective Meausre of Stress

Tables 6 and 7 show physical and mental stress data by scenario as reported by Soldiers. Physical and mental stress levels are quite low overall (around 2 on a ten-point scale). Of the scenarios with a valid number of observations, airport surveillance tended to result in somewhat higher reported levels of stress, perhaps for reasons cited before. In particular, Soldiers reported higher levels of stress for certain surveillance tasks (detecting targets and manipulating the sensor) and higher ratings of overall stress during that scenario. The stress levels for the airport-border scenario were slightly higher for tasks involving reporting (placing targets on map, using map tools, and verbal spot reports). Although GSR levels do indicate some degree of stress, particularly relative to scenario type and use of AiTR, subjective levels of stress are generally low.

Tables 8 and 9 present physical and mental stress data by time of day. Night scenarios appear slightly more stressful than limited day or combined day and night scenarios, again perhaps because Soldiers had to identify a target by thermal image only and did not have the ability to use visual references (i.e., terrain features) to assist in familiarization of the area of surveillance. Similar to the findings of subjective measures of workload, night runs extended late into the evening, which may have affected perceived mental and physical stress if Soldiers did not receive adequate rest before arriving at the test site.

Table 6. Mean physical stress rating by task by scenario.

Scenario	n	Overall Workload	Detecting Targets	Manipulating Sensor in Stare Mode	Placing Targets on Map	Using Map Tools	Providing Verbal Spot Reports
Highway surveillance	7	1.1	1.3	1.3.	.7	.7	1.1
Airport surveillance	7	2.3	2.4	1.9	1.4	1.3	1.3
Gate surveillance	1	1.0	1.0	1.0	1.0	1.0	1.0
Open terrain	13	1.6	2.2	1.9	1.3	1.3	1.1
Airport-border	4	1.8	2.3	1.5	1.8	2.0	1.5
Airport-open	1	2.0	4.0	2.0	2.0	2.0	2.0
Border-open	1	1.0	1.0	1.0	1.0	1.0	1.0
Overall mean	34	1.7	2.1	1.7	1.3	1.3	1.2

n = number of observations in that scenario

Table 7. Mean mental stress rating by task by scenario.

Scenario	n	Overall Workload	Detecting Targets	Manipulating Sensor in Stare Mode	Placing Targets on Map	Using Map Tools	Providing Verbal Spot Reports
Highway surveillance	7	1.3	1.6	1.1	.7	.7	1.1
Airport surveillance	7	2.7	2.6	2.3	1.6	1.4	1.3
Gate surveillance	1	1.0	1.0	1.0	1.0	1.0	1.0
Open terrain	13	1.9	2.0	1.9	1.4	1.2	1.2
Airport-border	4	1.5	1.8	1.5	1.8	1.8	1.5
Airport-open	1	2.0	4.0	2.0	2.0	2.0	2.0
Border-open	1	1.0	1.0	1.0	1.0	1.0	1.0
Overall mean	34	1.8	2.0	1.7	1.3	1.2	1.2

n = number of observations in that scenario

Table 8. Mean physical stress rating by task by time of day.

Time of Day	n	Overall Workload	Detecting Targets	Manipulating Sensor in Stare Mode	Placing Targets on Map	Using Map Tools	Providing Verbal Spot Reports
Limited day	10	1.2	1.9	1.8	.8	.8	1.1
Night	16	2.1	2.4	1.9	1.5	1.6	1.4
Combined	8	1.3	1.5	1.1	1.4	1.3	1.1
Overall mean	34	1.7	2.1	1.7	1.3	1.3	1.2

n = number of observations in that condition

Table 9. Mean mental stress rating by task by time of day.

Time of Day	n	Overall Workload	Detecting Targets	Manipulating Sensor in Stare Mode	Placing Targets on Map	Using Map Tools	Providing Verbal Spot Reports
Limited day	10	1.4	1.9	1.7	.8	.8	1.1
Night	16	2.2	2.4	1.9	1.6	1.5	1.4
Combined	8	1.6	1.3	1.4	1.4	1.3	1.1
Overall mean	34	1.8	2.0	1,7	1.3	1.2	1.2

n = number of observations in that condition

Tables 10 and 11 show physical and mental stress data by use of AiTR. It appears that intermittent use is associated with slightly higher stress levels, and not using AiTR is associated with some-what lower levels of stress. Perhaps the most stressful scenarios require Soldiers to be constantly switching between AiTR and manual modes of target acquisition. When Soldiers use AiTR, they

establish over time a certain familiarity with the image chips in terms of knowing which detections are false, which are not, and the location of image chips relative to each other and to the entire area of surveillance. Switching between AiTR and manual modes requires Soldiers to re-familiarize themselves with the area using a different approach. With AiTR activated, they must develop their SA using image chips and other AiTR features (i.e., cross referencing image chips with known targets emplaced on the SA screen). In manual mode, Soldiers must develop their SA via other, traditional methods. Switching between modes likely increases the Soldier's workload as additional cognitive resources are tapped while the Soldier transitions between alternate methods of SA development.

Table 10. Mean physical stress rating by task by use of AiTR.

Use of AiTR	n	Overall Workload	Detecting Targets	Manipulating Sensor in Stare Mode	Placing Targets on Map	Using Map Tools	Providing Verbal Spot Reports
AiTR used	15	1.5	2.0	1.5	1.3	1.2	1.2
AiTR not used	4	1.0	1.3	1.0	.5	.5	1.0
Intermittent use	15	1.9	2.3	2.0	1.5	1.5	1.3
Overall mean	34	1.7	2.1	1.7	1.3	1.3	1.2

n = number of observations in that condition

Table 11. Mean mental stress rating by task by use of AiTR.

Use of AiTR	n	Overall Workload	Detecting Targets	Manipulating Sensor in Stare Mode	Placing Targets on Map	Using Map Tools	Providing Verbal Spot Reports
AiTR used	15	1.7	1.8	1.7	1.3	1.3	1.2
AiTR not used	4	1.3	1.8	1.0	.5	.5	1.0
Intermittent use	15	2.1	2.3	2.0	1.5	1.4	1.3
Overall mean	34	1.8	2.0	1.7	1.3	1.2	1.2

n = number of observations in that condition

3.1.4 Objective Measures of Performance

Table 12 presents data about performance by type of scenario. Performance data were collected for only the three scenario types listed in table 12. For gate and border surveillance, distance of target was fixed for any given run, so the only item recorded was whether the target was detected. For the open terrain scenario, targets continued to move toward the scout until detected, so only distance detected was recorded. The "Distance Visible" column indicates the distance at which AiTR should theoretically be able to detect a target. For the gate scenario, Soldiers were able to detect more targets than detected by AiTR, that is, able to detect targets in addition to those cued to them by AiTR. However, in the border scenario, Soldiers detected slightly fewer targets than detected by AiTR, that is, did not detect all targets cued to them by AiTR. Since gate surveillance involved a narrower area to search, perhaps Soldiers could more effectively use the "stare" mode to detect targets rather than depending on cuing by AiTR. If Soldiers did use the stare mode more frequently than AiTR during gate surveillance, then it may follow that more manual detections were achieved simply because the time dedicated to scanning the environment was primarily spent

in the manual mode and not spent using AiTR. In the open terrain scenario, AiTR detected targets at slightly less than two-thirds of its theoretical range. Soldiers detected targets at about 85% of the range that targets were detected (cued to them) by AiTR. The difference in distances reflect AiTR and Soldier performance. The reduction in distance between when AiTR detects a target and when the Soldier detects the same target is indicative of several issues, such as the design of the interface and the resulting second order effects such as Soldier workload and stress. An ensuing assessment of the AiTR interface via a controlled study would provide more insight into how Soldier performance is affected.

Table 12. Mean performance by scenario.

Scenario Type	n	Distance Visible (km)	Distance Detected by AiTR (km)	Distance Detected by Soldier (km)	Percentage AiTR Detection	Percentage Soldier Detection
Gate surveillance	21	NA	NA	NA	48	62
Border surveillance	21	NA	NA	NA	81	71
Open terrain	44	7.5	4.6	3.9	NA	NA

n = number of observations in that condition

Table 13 shows performance data by time of day. Limited day runs were mostly open terrain or border surveillance, so distance data were similar to the data discussed for open terrain, and percentage data were the same as discussed for border surveillance. Night runs were mostly open terrain or gate surveillance, so the distance data were again similar to open terrain and the percentage detection data similar to gate surveillance. Perhaps the night runs for gate surveillance, when Soldiers were using thermal imagry to detect the targets, contributed to Soldiers being able to detect targets in addition to those cued to them by AiTR.

Table 13. Mean performance by time of day.

Time of Day	Distance Visible (km)	Distance Detected by AiTR (km)	Distance Detected by Soldier (km)	Percentage AiTR Detection	Percentage Soldier Detection
Limited day	7.4	4.7	3.9	81	71
Night	7.8	4.5	4.0	48	62

We did not collect objective performance data by mode of use of AiTR.

3.1.5 Subjective Measures of Performance

Table 14 presents SME ratings of performance by scenario. Overall, performance was rated as good (four or more on a five-point scale). However, ratings by SMEs may have been lenient, acknowledging the general lack of experience of the Soldiers serving as scouts in this demonstration. There did not seem to be any substantial differences in performance among scenarios with a valid number of observations, but identifying targets seemed to be the task with the lowest performance rating across all scenarios. Not every Soldier who participated in this study had experience as a scout. The baseline ablility of the Soldiers to detect, identify, and classify targets was not

identified. Therefore, attributing the target identification performance of the Soldiers to the design and performance of the AiTR cannot be done without further study.

Table 14. Mean performance rating by task by scenario.

Scenario	n	Detect Targets	Report Target Range	Report Target Heading	Classify Targets	Recog-Nize	Identify Targets
Highway surveillance	5	4.6	4.4	4.2	4.2	4.2	3.6
Airport surveillance	5	4.4	4.0	4.2	4.4	4.2	3.6
Gate surveillance	1	2.0	3.0	3.0	4.0	4.0	3.0
Open terrain	9	4.1	4.0	3.9	4.1	4.0	3.7
Airport-border	2	4.0	3.5	4.0	4.5	4.0	3.5
Airport-open	1	3.0	4.0	4.0	4.0	4.0	3.0
Border-open	1	4.0	3.0	4.0	4.0	4.0	4.0
Overall mean	24	4.1	4.0	4.0	4.2	4.1	3.6

n = number of observations in that scenario

Table 15 shows SME ratings of task performance by time of day. There do not seem to be any large or consistent differences among time of day and performance.

Table 15. Mean performance rating by task by time of day

Time of Day	n	Detect Targets	Report Target Range	Report Target Heading	Classify Targets	Recognize	Identify Targets	Recognize Re-Acquisition
Limited day	7	4.1	4.4	3.9	4.0	4.0	3.7	4.3
Night	11	4.0	3.8	3.9	4.3	4.0	3.6	4.1
Combined	6	4.3	3.7	4.3	4.3	4.3	3.5	4.2
Overall mean	24	4.1	4.0	4.0	4.2	4.1	3.6	4.2

n = number of observations in that condition

Table 16 presents SME ratings of task performance by AiTR use. Ratings for detecting targets, reporting range and headings were slightly higher when AiTR was not used. Ratings for classifying, recognizing, identifying targets, and recognizing re-acquisitions were higher for intermittent use. This suggests that the manual mode was used to initially detect targets (such as when an observation post [OP] was first occupied), but Soldiers then switched to AiTR mode to identify new targets.

Table 16. Mean performance rating by task by use of AiTR.

Use of AiTR	n	Detect Targets	Report Target Range	Report Target Heading	Classify Targets	Recognize	Identify Targets	Recognize Re-Acquisition
AiTR used	9	4.2	3.9	4.1	4.1	3.9	3.4	3.9
AiTR not used	3	4.7	4.7	4.3	4.0	4.0	3.3	4.0
Intermittent use	12	3.9	3.8	3.8	4.3	4.3	3.8	4.4
Overall mean	24	4.1	4.0	4.0	4.2	4.1	3.6	4.2

n = number of observations in that condition

3.2 Objective 2: Soldier-System Interface

Table 17 shows Soldier assessment of the FLIR. If at least five of the seven Soldiers (71%) rated an item as "good" or "very good," the item was considered "green," indicating predominantly satisfactory Soldier responses. If at least five of the seven Soldiers rated an item as "poor" or "very poor," the item was considered "red," which indicates that most Soldiers were not satisfied. If the item did not meet the criteria for "red" or "green," it was considered "amber," indicating a mix of responses which, given the small sample size, may simply reflect varying personal preferences. For the FLIR, most Soldiers appeared to be satisfied. In fact, only one Soldier (at most) rated any item regarding FLIR in the two lowest categories. However, Soldier ratings indicate mixed satisfaction for the 6-second delay from real time on the gimbal search mode, polarity adjustment, and focus. All other aspects of FLIR received generally positive ratings. Comments about the 6-second delay were that when Soldiers switched from the search to stare mode, the delay seemed much longer than 6 seconds. One Soldier wanted to be able to set the delay rate because sometimes the 6-second delay resulted in too many updates, particularly for less busy areas of reconnaissance such as open terrain. Concerning the polarity adjustment, the consensus was that the adjustment should be on the joystick. Soldiers commented that the focus worked intermittently.

Table 17. FLIR ratings.

Question (n = 7)	Percent Poor and Very Poor Ratings	Percent Borderline Ratings	Percent Good and Very Good Ratings
Gimbal (automatic search) mode	0	14	86
Six-second delay from real time on gimbal mode	14	29	57
Stare mode (directed search by scout)	0	0	100
"Lazing" target in stare mode and having it displayed on SA map	14	0	86
AiTR mode	0	14	86
Gain adjustment	0	0	100
Level adjustment	0	0	100
Polarity adjustment	14	29	57
Focus	14	43	43
Zoom (sufficient amount of sensitivity)	0	0	100
Panning (sufficient amount of sensitivity)	0	0	100
Wide and narrow fields of view (sufficient coverage)	0	0	100
Overall usability of the controls to operate the sensor	0	29	71

Table 18 presents Soldier assessments of AiTR. For reporting the survey data, the same criteria as discussed with FLIR were used. Overall, Soldiers indicated that they were satisfied with almost all of the aspects AiTR listed in table 18. The false alarm rate, miss rate, and drop-off rate for chips, however, received mixed ratings. Twenty-nine percent of the Soldiers did not provide positive ratings for AiTR when the STI mode was employed. The low ratings for STI are supplemented by Soldier comments stating that the false alarm rate was higher during STI than MTI. Comments about the overall false alarm rate were that it was high but could be corrected if the confidence with which something was detected to be a target were adjusted. Concerning the miss

rate, several Soldiers noted that the stationary target identification mode failed to detect many targets. Concerning the drop-off rate for chips, several comments indicated that the chips dropped off too fast to locate targets, and that one should be able to set the drop-off rate.

Table 18. AiTR ratings.

Question (n = 7)	Percent Poor and Very Poor Ratings	Percent Borderline Ratings	Percent Good and Very Good Ratings
False alarm rate	14	57	29
Hit rate (i.e., detecting a target when one actually exists)	0	29	71
Miss rate (i.e., not detecting a target when there actually is one)	0	43	57
Symbology	0	0	100
Performance of AiTR in airfield security scenario	0	0	100
Performance of AiTR in checkpoint scenario	0	0	100
Performance of AiTR in border surveillance scenario	0	0	100
Performance of AiTR in highway surveillance scenario	14	0	86
Performance of AiTR in open terrain	0	0	100
Performance of AiTR during daylight	0	29	71
Performance of AiTR at night	0	0	100
Stationary target indicator (STI)	29	0	71
Moving target indicator (MTI)	0	0	100
Simultaneous MTI and STI	0	0	100
Idea of an auditory alarm for new target located	14	14	71
Buffer size (10) for image chips	0	0	100
Drop-off rate for image chips	14	29	57
Ability to detect a group of targets (e.g., a convoy)	0	0	100

There were some additional comments about the interface, which were recorded during the interviews (a synopsis of comments is provided in appendix J). Concerning the field of view (FOV), it seemed that the FOV of 4x magnification and beyond was blurry. Also, Soldiers indicated that it should be easier to switch between the different FOVs. Soldiers indicated they did not use the color coding provided for distinguishing between image chips. In fact, many suggested that azimuth readings be applied to the image chips in place of the color coding in order to assist in the identification and organization of the chips. Regarding the use of AiTR at night, some Soldiers seemed to think it worked better at night than during the day, but others noted no differences. Because of the low sample size, AiTR performance at night versus day may have been coincidental. Some Soldiers thought that recognizing target re-acquisitions was a problem, although this was not unanimous. Concerning the screen layout, the consensus was that it was good, with perhaps some "hot keys" added for clearing detections and going to white hot. When asked if any information was missing from the display, Soldiers requested grid coordinates. Concerning critical information that was easy to overlook, Soldiers indicated that knowing which polarity one was in, what mode one was in (search or stare), remembering to clear detections, and set elevation were easy to overlook. Soldiers requested an ability to "set" elevation to a level at which it would stay, unless manually changed. Concerning controls, making the joystick adjustable for left-handed Soldiers was a concern. Several Soldiers recommended getting rid of the mouse and putting all controls (contrast, brightness, polarity) on the joystick. Concerning overall workload,

one Soldier noted that this was increased when there was a large area to cover. Another noted that sending spot reports would add greatly to workload.

3.3 Objective 3: TTPs

Several interview questions concerned TTPs. Soldiers indicated that they used the gimbal search mode and AiTR to detect targets and then went into the stare mode to classify, identify, and recognize targets. Soldiers adjusted gain and contrast darker when it was hot. The use of black or white hot polarity seemed to be a personal preference, with no clear consensus. Soldiers indicated that they used AiTR about the same over the various scenarios. Concerning the use of STI and MTI, Soldiers indicated they used STI when first occupying an OP to get a general overview of the situation and what was in the OP. Then they switched to MTI to identify new potential threats.

4. Discussion

Overall, it appears that Soldiers can use the AiTR configuration presented here. Generally, workload was low and stress was low (subjective ratings) to moderate (GSR). Objective performance indicated that Soldiers detected slightly less to slightly more (depending on the scenario) than the number of targets presented to them via AiTR, at roughly the distance at which AiTR detected targets. SME ratings suggested that overall performance was good, with target identification as the most challenging task. However, SME ratings may have been lenient because of the Soldiers' inexperience.

Workload and subjective stress was highest for the airport scenario, perhaps because of the complexity of the environment in terms of activity and distance to be covered. The objective measure of stress (GSR) showed that all frequently run scenarios doubled Soldiers' stress levels compared to their baseline levels. The SME ratings of performance did not vary by scenario. However, objective measures suggested that in the gate scenario, participants detected slightly fewer targets than were presented by AiTR, while in the border scenario, participants identified slightly more targets than presented by AiTR, perhaps because the gate was a more constricted area to watch. Open terrain performance was about 80% as good as AiTR would allow in terms of distance form which targets were identified.

Workload and stress (both subjective and GSR) were somewhat higher at night, suggesting that identifying targets from only a thermal signature and the inability to use terrain features available during daylight may be more challenging. However, night scenarios may be less stressful for scouts who have more experience using thermal imagery at night. Subjective ratings of performance did not vary by time of day. Objective performance was confounded with scenario, with all day runs being open terrain or border surveillance and all night runs being gate surveillance.

Workload and stress measures suggest that intermittent use of AiTR results in greater stress, perhaps because of the necessity of constantly switching modes and the effects of re-establishing SA, based on the features of each mode (i.e., refamiliarizing oneself with image chips). The SME ratings of performance suggest that target detection is better without AiTR, but recognition is better with intermittent use. This may reflect the practice of Soldiers using the stare mode when first occupying an OP and then switching to AiTR to monitor the OP. No objective performance measures were collected by the use of AiTR.

There were several user comments concerning improvement of FLIR, AiTR, and the interface in general. Concerning FLIR,

- The supposed 6-second delay between search and stare modes seemed longer; it should be shortened. Likewise, the ability to manually adjust the delay time (i.e., lengthen it during non-complex environments) would be helpful.
- The polarity control should be on the joystick.
- The focus control should work consistently (seemed to work only intermittently).

Concerning AiTR,

- The false alarm rate was high but could be controlled if the confidence level were set high.
- The STI mode needs improvement since it failed to detect many targets.
- The drop-off rate for AiTR chips was too rapid; it should be adjustable.

General comments

- The FOV of 4x or beyond was blurry and needs to be clearer.
- The color coding of symbols is not used or needed
- The SA map needs grid coordinates.
- Cues are needed to allow the operator to know which polarity is being used.
- Cues are needed to allow the operator to know which mode (search or stare) is currently activated.
- A prompt is needed that reminds the operator to clear detections and set elevation when switching from live to stare to search mode.
- Put all controls on the joystick.

A few major TTPs were identified. These included

- Use AiTR to detect targets, then use stare mode to identify targets.
- Use STI when first in an OP to get an idea of what is there; then use MTI to identify new threats.
- Set gain and contrast darker when it is hot.

5. References

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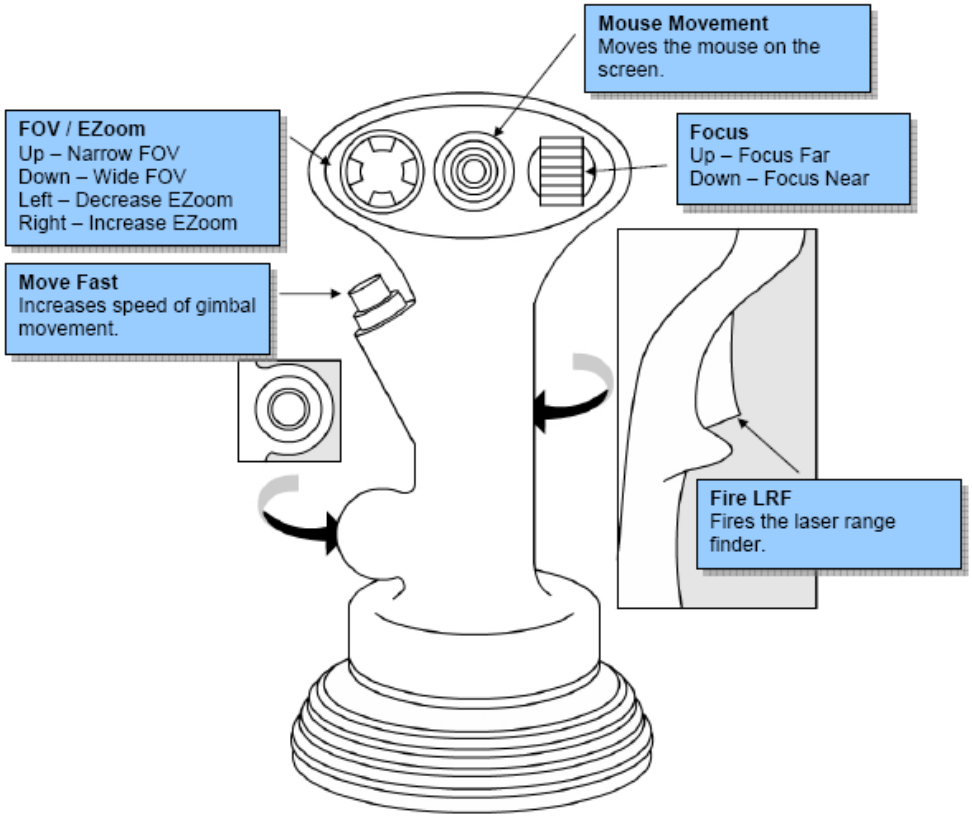
Appendix A. Crew Station and Joystick Control

Crew Station



Joystick Control

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Appendix B. Demographic Questionnaire

Age: ___ ___

Rank: ___ ___

Time in Service: ___ ___ Years and ___ ___ Months

Primary MOS (if enlisted): ___ ___ ___

Branch (if officer): _____

Time in MOS or Branch: ___ ___ Years and ___ ___ Months

Are you: __ Left handed ___ Right handed ____ Ambidextrous

Do you wear: ___ Glasses ___ Contact lenses ___ Neither

Are you color blind? ___ No ___ Yes

Have you used FLIR before? ___Yes ___ No

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Appendix C. Bedford Workload Scale Questionnaire

Scenario (check one): ___ Highway surveillance ___Airport surveillance (MOUT) ___Gate surveillance ___Border surveillance ___Open terrain _____Other (Specify)

Time of day (check one): ___Limited Day ___Night AiTR mode (check one): ___Used ___Not used ____Intermittent Use

Assessment of workload. Rate the workload of the following tasks on the following scale

Task	Workload Insignificant (1)	Workload Low (2)	Enough spare capacity for all desirable additional tasks (3)	Insufficient spare capacity for easy attention to additional tasks (4)	Reduced spare capacity additional tasks cannot be given the desired amount of attention (5)	Little spare capacity level of effort allows little attention to additional tasks (6)	Very little spare capacity but maintenance of effort in the primary task is not in question (7)	Very high workload with almost no spare capacity difficulty in maintaining level of effort (8)	Extremely high workload no spare capacity and difficulty in maintaining level of effort (9)	Task abandoned unable to apply sufficient effort (10)
a. Overall workload										
b. Detect Targets (scan display screen)										
c. Manipu-late sensor in stare mode										
d. Place targets on situation map using chips										
e. Use map tools to place target on situation map (if applicable)										
f. Provide verbal spot reports										

Appendix D. Subjective Measure of Stress

Scenario (check one): ___ Highway surveillance ___Airport surveillance (MOUT) ___Gate surveillance ___Border surveillance ___Open terrain _____Other (specify)

Time (check one): ___Limited Day ___Night

AiTR mode (check one): ___Used ___Not used ____Intermittent Use

1. The scale below represents a range of how PHYSICALLY stressful a task might be. Check the block indicating how PHYSICALLY stressful each of the tasks below were in the scenario that you just performed.

Task	Not at All Stressful 1	2	3	4	5	6	7	8	9	Most Possible Stress 10
a. Overall stress										
b. Detect Targets (scan display screen)										
c. Manipulate sensor in stare mode										
d. Place targets on situation map using chips										
e. Use map tools to place target on situation map (if applicable)										
f. Provide verbal spot reports										

2. The scale below represents a range of how MENTALLY stressful a task might be. Check the block indicating how MENTALLY stressful each of the tasks below were in the scenario that you just performed.

Task	Not at All Stressful 1	2	3	4	5	6	7	8	9	Most Possible Stress 10
a. Overall stress										
b. Detect Targets (scan display screen)										
c. Manipulate sensor in stare mode										
d. Place targets on situation map using chips										
e. Use map tools to place target on situation map (if applicable)										
f. Provide verbal spot reports										

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Appendix E. Objective Performance Measures

Scenario (check one): ___ Highway surveillance ___Airport surveillance (MOUT) ___Gate surveillance ___Border surveillance ___Open terrain _____Other (specify)

Time (check one): ___Limited Day ___Night AiTR mode (check one): ___Used ___Not used ____Intermittent Use

No.	SME Time in Sensor View	SME Description of Target	Scout Reported As Re-Acquisition (Y Or N)	Time Scout Acquired	Scout Description	Type Acquisition (D,C,R,I)	Scout Reported Heading	Heading of Target (to be added)	Range to Target When Acquired (to be added)

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Appendix F. Subject Matter Expert (SME) Ratings

Scenario (check one): ___ Highway surveillance ___Airport surveillance (MOUT) ___Gate surveillance ___Border surveillance ___Open terrain ____Other (Specify)

Time of day (check one): ___Limited Day ___Night

AiTR mode (check one): ___Used ___Not used ____Intermittent Use

Rate the performance of the scouts for:

Item	Very Poor	Poor	Borderline	Good	Very Good
a. Detecting targets					
b. Reporting target range					
c. Reporting target heading					
d. Classifying targets					
e. Recognizing targets					
f. Identifying targets					
g. Recognizing a target as a re-acquisition of a prior target (versus new target)					

For any rating of "Poor" or "Very Poor," please explain the basis of your rating:

_____

_____

_____

_____

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Appendix G. Soldier-Machine Interface Questionnaire

Forward Looking Infrared Radar (FLIR) questions

Rate your assessment of various aspects of FLIR by marking an "X" in the appropriate block.

Question	Very Poor	Poor	Borderline	Good	Very Good	N A
a. Gimbal (automatic search) mode						
b. Six second delay from real time on gimbal mode						
b. Stare mode (directed search by scout)						
c. Lazing target in stare mode and having it displayed on situational awareness map						
d. AiTR mode						
e. Gain adjustment						
f. Level adjustment						
g. Polarity adjustment						
h. Focus						
i. Zoom (sufficient amount of sensitivity)						
j. Panning (sufficient amount of sensitivity)						
k. Wide and narrow fields of view (sufficient coverage)						
l. Overall usability of the controls to operate the sensor						

For any questions that received a Borderline, Poor or Very Poor rating, please state why:

_____

_____

_____

Rate your assessment of various aspects of aided target recognition (AiTR) by marking an “X” in the appropriate block.

Question	Very Poor	Poor	Border line	Good	Very Good	N A
a. False alarm rate						
b. Hit rate (i.e., detecting a target when one actually exists)						
c. Miss rate (i.e., not detecting a target when there actually is one)						
d. Symbology						
e. Performance of AiTR in airfield security scenario						
f. Performance of AiTR in check point scenario						
g. Performance of AiTR in border surveillance scenario						
h. Performance of AiTR in highway surveillance scenario						
i. Performance of AiTR in open terrain						
j. Performance of AiTR during daylight						
k. Performance of AiTR at night						
l. Stationary Target Indicator (STI)						
m. Moving Target Indicator (MTI)						
n. Simultaneous MTI and STI						
o. Idea of an auditory alarm for new target located						
p. Buffer size (10) for image chips						
q. Drop off rate for image chips						
r. Ability to detect a group of targets (e.g., a convoy)						

For any questions that received a Borderline, Poor or Very Poor rating, please state why:

_____

_____

Appendix H. Interview

AiTR Study Interview

Forward Looking Infrared Radar (FLIR) questions:

1. When do you use the gimbal (automatic search) mode, stare (directed by scout) mode, the AiTR mode, and binoculars?

2. What do you think about the mode where you go into stare mode on a target, laze it, and have it pop up on the situation awareness map?

3. How does the six second delay on the gimbal scan mode affect you?

4. How do you use the gain (contrast)?

5. How do you use the level (contrast)?

6. When do you adjust the polarity (white hot versus black hot)

7. How is the difference in sensitivity of zoom and pan- different enough or not very distinguishable?

8. How are the differences in field of view- different enough or not very distinguishable?

9. Are there any problems about how targets are reported using the interface (assuming this ability exists)

Aided Target Recognition (AiTR) questions:

1. What do you think about the AiTR false alarm rate?

2. What do you think about the ability of AiTR to detect targets (that is hits versus misses)?

3. What do you think about the symbology used on the interface?

4. Are there differences between how you use AiTR in different scenarios? (MOUT, check point, border surveillance, road surveillance, open terrain)?

5. How does AiTR work in day versus night?

6. When do you use Stationary Target Indication, Moving Target Indication, and both simultaneously?

7. What do you think about the drop-off rate of AiTR chips (targets identified)? What do you think about the buffer size of ten AiTR chips?

8. Is it difficult to tell when a chip represents a re-acquisition of a previously acquired target versus a new target?

9. What do you think about AiTR's ability to identify groups of targets (e.g., a convoy)? Would identifying one target per group be enough?

10. How is the layout of the screen displays for the sensor data (e.g., are they co-located logically)?

11. How is the sizing of menu items (image chips, fonts, etc.)

12. How is the color coding of brackets?

13. Is there any information missing from any of the displays that would increase your effectiveness in performing your tasks?

14. Are there any alerts or warnings that could help you perform your tasks more effectively?

15. Is any critical information easy to overlook?

Control (joystick, mouse, keyboard) questions:

1. How is the layout of all controls and displays inside the vehicle?

2. How easy is it to use the controls overall for manipulating the sensor?

3. How easy is it using the joystick in conjunction with other controls (e.g., mouse and keyboard) to perform your tasks?

4. How is the sensitivity of the controls for panning and zooming with the sensor?

5. How is the ability to adjust sensitivity when needed?

6. How easy is it to switch your field of view from wide to narrow using the controls?

7. How easy is it to zoom in and out using the controls?

8. How easy is it to use controls for changing contrast, brightness and polarity?

9. Is there any aspect of the controls or displays (location, sizing, menus, etc.) that could cause a Soldier to make any mistakes?

Workload related questions:

When do you experience high workloads (for instance, certain scenarios, certain tasks)?

Why do you think the workload is high in those situations?

Appendix I. Draft Scenarios

Target Acquisition Sensor Suite (TASS)

Outline for YPG 2006 Scout Experiment
v.1 (12/15/05)

1. Introduction

Currently fielded infrared sensors are staring, i.e. they provide a live image with field of view of a few degrees. They are manually slewed and the only area being interrogated at any instant is the current field of view. A gimbal scanned sensor, on the other hand, provides a much wider azimuth field of view, but at the expense of a much slower refresh rate. The TASS LWIR sensor provides a gimbal-scanned image of up to 90 degrees in azimuth and with a image refresh period of six seconds. This imagery can include symbology of targets detected with our current AiTRs.

The primary purpose of this experiment is to gauge the utility of gimbal-scanned FLIR and modes of AiTR with senior enlisted scouts and junior armor officers. We want to understand how they would use these sensor capabilities in field scenarios, and get their opinions and suggestions for improvement and emphasis. We also want to show them the capabilities and limitations of state-of-the-art AiTRs

RSTA scenarios using tactical vehicles will be run on the ranges at YPG viewable from five different scout observation points (OP). Over a 2-day cycle, the sensor and a pair of Soldiers will visit the OPs and accomplish a variety of RSTA missions with the sensor. The Soldiers will be monitored and interviewed by ARL psychologists, who will provide the human factors analysis.

2. Schedule (tentative)

Mar 20 – 23:	Equipment arrival and setup.
Mar 24 - 25:	Data collections on experiment scenarios (day & night).
Mar 27 – Apr 8:	Experiment consisting of six 2-day scenario cycles
Apr 10:	Equipment packup

3. Targets (tentative)

- The scenarios are still being designed, but we can anticipate multiple target arrays with up to two large (4-target) or three small (2-target) arrays being run simultaneously.

Soviet Array 1 : T-72, BMP, BTR, BRDM (Cibola)
Soviet Array 2: T-72, BMP (Laguna)
Soviet Array 3: BTR, BRDM (Laguna)
US Array 1: M-60, M-2, HMMWV, Truck (Cibola)
US Array 2: M-60, M-2, HMMWV, Truck (Cibola)
Technical Array: 2 Nissan pickups (Laguna)

The OPs and ranges we'd like to use are:

a. Site 9 - Cibola
b. Site 2 - Cibola
c. Flat Hill 1 overlooking LAAF, MTD and Laguna Mtns.
d. Flat Hill 2 overlooking LAAF, MTD and Laguna Mtns.
e. Hwy 95 and LAAF from point just off Hwy 95 at the southern property boundary.

4. Scenario Outline

Tentative ordering of the OPs with a brief description of the target and Soldier activity. Scenarios are a work in progress. The scenarios will repeat over the two-week experiment period, cycling every two days.

Day 1 – OP Site 9 (1700-2000)

The scenario begins with the two US arrays in view, one of them manned and idling while the other is unmanned & cold. A Soviet array is downrange and out of view.

The Soldier does an initial range reconnaissance against the stationary (STI) targets for about 15 minutes. The manned target array then maneuvers to the cold array, where they do a relief in place. The drivers shut down the hot array and man the cold array, which then maneuvers well to the south (> 10 km) and out of view.

After a dead period of no range activity (30-60 minutes), the Soviet array maneuvers north toward the sensor from very long range (15 km). While the Soviet array is moving north, the US array comes into view again, also moving north but at a significantly different azimuth than the Soviet array. This is to get two arrays moving simultaneously to increase the operator workload and motivate gimbal scanning. Both array will maneuver so they are only intermittently in view.

When the Soviet array reaches a TBD position (~ 5 km from sensor), the vehicles take up static positions. Sometime after, the moving US array also takes up static positions.

Day 1 – OP Flat Hill 1 (2100-2400)

This scenario includes a number of events, some that will occur simultaneously. It will use two 2-target Soviet arrays and the Technical array.

- One of the Soviet arrays comes out of the Laguna Mtns. from the Tanks Hill/Truck Hills courses and maneuvers in the desert (on existing trails) between the mountains and Laguna Dam Road. This will occur for 45-60 minutes on a planned route to provide a variety of moving target looks in the same field of view as significant civilian traffic.

- The other Soviet array will maneuver in the desert between Hwy 95 and LAAF – the same area used during the 2004 data collection. Their movement will be intermittent.

- The technical array will maneuver to a couple of positions and provide views of dismount activity. These will include setting up a mortar positions against LAAF and "suspicious" activity around the MTD water-tower, such as loading/unloading crates.

- The Soldier will be asked to report whenever a Dodge pickup (or other specific vehicle) enters or exits YPG through the LAAF gate.

Day 2 – OP Hwy 95 (1700-1800)

The Soldier will be monitoring Hwy 95 and at least two named areas of interest (NAI), such as the LAAF jump tower and Middle East road course, for suspicious activity. This OP include numerous events, some occurring simultaneously.

- One of technical vehicles will maneuver from the desert onto the highway. After driving on the highway for some distance, it will pull off and drop a package by the side of the highway. It will then depart the highway into the desert.

- A non-descript civilian vehicle will stop along the side of the highway for a short period. This will occur on the stretches both north and south of the Laguna Dam Rd.

- A two-target Soviet array will maneuver in the desert near the jump tower and set up a static position.

- Technical vehicles will maneuver up the Middle East course to give a good azimuth divergence with the activity around the jump tower.

- The Soldier will report any vehicles on Hwy 95 towing a boat

Day 2 – OP Flat Hill 2 (1900-2100)

Same general activities as Flat Hill 1, but from a slightly different perspective. Soldier resources will also vary slightly, such as access to AiTR reports.

Day 2 – OP Site 2 (2200-2400)

Beginning at static positions far downrange, the Soviet array (near Site 12) and one US array (near Site 7B) will maneuver north to south. The Soviet array will use the west side of the Cibola Basin, while the US array will generally move down Middle Mtn Road.

On or near Water Tank Rd., the two arrays set up in static positions to provide target ranges of 3-7 km. The experiment ends here, but we will follow with a short demo of having the Soldier use active SWIR to ID the targets.

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Appendix J. Interview Responses

FLIR

1. When do you use the gimbal, stare, AiTR?

Soldier 1: Go live to identify a hit from the AiTR. If refreshes every 6 seconds it's good. Let it refresh 2 times and see what movement there is within a bottom box. Static mode- good for a quick scan.

Soldier 2: Go live when I see a heat signature in the scan mode, detection of movement or a vehicle profile. Used live mode more when it was hot outside because the sensors picked up everything, when lots of false targets were coming up.

Soldier 3: Use the WAS mostly, then if I think I see something I go live, or if tracking something.

Soldiers 4 and 5: Scan helps with quick target reference. Use live gives you ability to get self controlled detailed look at things. If you're coming across things and you don't think something is there, you can click in the brackets and look at it without having to go into live mode. One guy preferred live mode. Other said you can cross a wide sector in WAS.

Soldiers 6 and 7: Try to stay away from live mode and use the scan. Used live scan for highway.

2. What do you think about the mode where you go into stare mode on a target, laze it, and have it pop up on the SA map?

Soldier 1: N/A didn't use. But, need to re-orient the map so that its terrain orientated. So up is always front of the vehicle. Have the capability to flip it.

Soldier 2: Didn't seem hard too do, just try to line up the cross hairs. Would be nice to keep the dots on the SA map and code the order you put them in.

Soldier 3: It's quick, a push of the button.

Soldiers 4 and 5: No issues.

Soldiers 6 and 7: No issues.

3. How does the 6 second delay affect you?

Soldier 1: 6 sec delay ok if it works. When you switch from live mode to scan mode the machine acted up, would take up to 45 seconds to start scanning.

Soldier 2: Depends on the action in the area. Sometimes the 6 seconds seemed too much, like when it's slow.

Soldier 3: It's good but seems to take a little bit longer to refresh after coming off of live mode. Happy with it otherwise.

Soldiers 4 and 5: One guy said the chips dropped off too fast. One guy liked the 6 second rate; he waited for the refresh rate to determine movement of a target.

Soldiers 6 and 7: Was enough time. Had enough time to see if the targets were moving or not.

4. How do you use the gain?

Soldier 1: Gain/contrast and Level/brightness. Used it plenty of times, depending on the ambient temp and the sunlight. When the shadows change, I'll adjust gain/contrast. In the day, the fidelity isn't there because of the ambient heat.

Soldier 2: Used it depending on the heat in the area to try to pick up targets better.

Soldier 3: Adjust to the heat signatures. Likes it dark because when in the white hot.

Soldiers 4 and 5: If ambient heat is hot and everything is bright, you can change it to get a better idea of what you're looking at. One guy preferred dark. Sometimes just like to change it to see.

Soldiers 6 and 7: Set it once in the beginning and didn't mess with it.

5. How do you use the contrast?

Soldier 1: Answered above.

Soldier 2: Used it depending on the heat in the area to try to pick up targets better.

Soldier 3: Adjust to the heat signatures. Likes it dark because when in the white hot.

Soldiers 4 and 5: Answered above.

Soldiers 6 and 7: Answered above.

6. When do you adjust the polarity?

Soldier 1: Prefer black hot for scanning and most everything else. This is a personal preference. Close range for fine detail use black hot (pilots tend toward this per Mark Gahler).

Soldier 2: Depending on where the vehicle was located or to get a better read for determining if a vehicle was wheeled or tracked. Couldn't tell which would pick up better, no pattern for when one was better than the other but used it to get a better picture.

Soldier 3: Always keep it in white hot, don't like the black hot but use it sometimes just to see the vehicle differently.

Soldiers 4 and 5: One likes to switch back and forth. Would be better if it was where the focus button was. Make focus up/down and polarity left/right. Work it in somewhere. Use it often and quickly

Soldiers 6 and 7: Prefer black hot all the time. Sometimes switch to white hot when close up to a target to try to get a better picture.

7. How is the difference in sensitivity of zoom and pan?

Soldier 1: Sensitivity is fine, it's distinguishable enough. No problems with the stick. Just need it to be good enough to laze a target.

Soldier 2: Large difference between the 1x, 2x, 4x and was good. Gaps were fine.

Soldier 3: Likes the zoom but in the 4^{th} power it's fuzzy- not a clear picture.

Soldiers 4 and 5: No issues.

Soldiers 6 and 7: No issues.

8. How are the differences in field of view?

Soldier 1: FoV (1x, 2x, 4x)- it's good. 4x is blurry (not pixilated, but blurry). The differences are sufficient, just that 4x is blurry.

Soldier 2: Wide versus narrow was good. Tended to keep in narrow because it was the easiest way to see.

Soldier 3: Both have their plusses. Prefer to use narrow field of view.

Soldiers 4 and 5: Yes, any more than 4x and it's not clear.

Soldiers 6 and 7: It was enough with the 1x, 2x and 4x.

9. Are there any problems about how targets are reported using the interface?

Soldier 1: Only reported using the radio.

Soldier 2: Didn't really use enough to determine.

Soldier 3: No issues.

Soldiers 4 and 5: No issues.

Soldiers 6 and 7: No issues.

AiTR

1. What do you think about AiTR false alarm rate?

Soldier 1: When wind blows the AiTR picks up lots of false targets- i.e., sage brush. Would rather have more pings and re-visits than nothing to see and get worried. With training you'll be able to downplay the pings and get used to them. This is the same for MIT and STI.

Soldier 2: Liked being able to adjust the confidence. Set at a confidence to pick up everything and when you get comfortable it was good to be able to turn it down. With more familiarity the false alarms weren't a real hindrance. In reality, you'll know the character of your terrain. By the way, a directional arrow on the SA map would be good.

Soldier 3: Seems to get a lot of hits that aren't there but would rather have too many than missed hits. Also depends on how you set the confidence.

Soldiers 4 and 5: Regarding STI: Picked up way too many false alarms. Can't recall any actually being picked up. Regarding MTI: Depending on the confidence level. When confidence is high it still picked up something. Seemed like 90% of the time AiTR wasn't used to detect targets. Manual scanning helped more than AiTR. Can't use AiTR in a highway scenario, prefer manual scan. It does help like if you're scanning the East side of a sector and it picks up something on the West side you can go back quickly.

Soldiers 6 and 7: Regarding STI: Picked up a lot of hot spots. Found targets on their own without using AiTR. Was able to distinguish what was hotspots and what was real. Regarding MTI: About the same in STI.

2. What do you think about the ability of AiTR to detect targets (that is hits versus misses)?

Soldier 1: Regarding MTI, was fine, but major glitch was daytime- being able to get the clarity and fidelity. Was looking for dismounts as they are important targets to look for- they dismount their vehicles. The ambient heat makes it difficult. Regarding STI, first night worked fine.

Soldier 2: It was great, impressed with the capabilities. Even the stationary Humvee was picked up real well. Sensor picked up a clear picture and the air movement and dust was used to pick up some moving vehicles.

Soldier 3: Good.

Soldiers 4 and 5: Regarding STI: Poor. Regarding MTI: Good.

Soldiers 6 and 7: Regarding STI: It detects them but could do it quicker on his own. Regarding MTI: Detected better than STI.

3. What do you think about the symbology used on the interface?

Soldier 1: Only comment on symbology had to do with the color coding of the chips- see comment below in the appropriate section.

Soldier 2: In order to pick up detections (via the brackets) I used the lowest bar, not the WAS.

Soldier 3: Good.

Soldiers 4 and 5: Looked at the squares and didn't use the color coding.

Soldiers 6 and 7: Didn't pay attention to the color coding. Just noticed the brackets. Mostly anything that moved

4. Are there differences between how you use AiTR in different scenarios?

Soldier 1: Used AiTR the same in all scenarios.

Soldier 2: At night the hits were more accurate, so the confidence level changed. Pretty much used it the same.

Soldier 3: Tried to vary what I did.

Soldiers 4 and 5: Highway system only. Otherwise, we used it the same.

Soldiers 6 and 7: Used it the same in all scenarios.

5. How does AiTR work in day versus night?

Soldier 1: The hits were there regardless of the time of day.

Soldier 2: During the day there were more false alarms, at night the hits were more accurate.

Soldier 3: Works the same both ways.

Soldiers 4 and 5: Liked it better at night. If it's really hot the FLIR will pick up everything or nothing.

Soldiers 6 and 7: Didn't notice a difference.

6. When do you use STI, MTI?

Soldier 1: Used STI at first 5 minutes at an OP. Setting left and right limits and getting familiar with the terrain. Then, switch to MTI. How much time on live mode needed to familiarize oneself with this area of search: Probably more than 5 minutes. It's directly proportionate to your area of responsibility- must gain an understanding of what the Soldier is looking at (priority information requirements) and where it's supposed to happen- where targets will likely pop up.

Soldier 2: When getting familiar with the area would use STI then switch to MTI.

Soldier 3: At this point, STI and MTI usage was dictated to the Soldiers by the test director in order to make sure the Soldiers had an opportunity to spot the stationary vehicles.

Soldiers 4 and 5: N/A

Soldiers 6 and 7: N/A

7. What do you think about the drop off rate of the AiTR chips? What do you think about the buffer size?

Soldier 1: Drop off rate of AiTR chips. Refresh rate is fine. Would be good to let the chip sit up there through 2 refreshes (i.e., 12 seconds). Maybe let the user control the update rate of the image chips. Number of chips (10)- it's enough. 6 seconds isn't enough time to check out all 10 chips.

Soldier 2: Would like to be able to set it manually.

Soldier 3: Time frame is good. Would want to have a confidence priority from left to right. Left is high to right which is low. It's a good amount [buffer size]. Any more and you'd cut down the size of the chips.

Soldiers 4 and 5: Don't stay up long enough. If they could stay up after the screen refreshed. 10 was plenty. With the refresh rate as it was you couldn't go through all 10 chips. When they had 10 they would just boost their confidence level up. They boosted the confidence because they knew they wouldn't be able to see them all within the 6 second refresh rate.

Soldiers 6 and 7: Was just fine. Looked at them a lot. If they disappeared they came right back. Memorized the azimuth and looked for it to come back up. One liked it. One didn't like it- too much to look at. One guy used a zig zag mode- scanning the whole screen: Look at the chips, go to middle screen, then down to lowest bar.

8. Is it difficult to tell when a chip represents a re-acquisition of a previously acquired target versus a new target?

Soldier 1: Not difficult.

Soldier 2: No, I would look at the number of the chip.

Soldier 3: It was hard to figure out the re-acquisitions.

Soldiers 4 and 5: If you can remember the azimuths for each chip then no. Otherwise, yes.

Soldiers 6 and 7: Yes, checked the azimuth to see if AiTR was a repeat.

9. What do you think about AiTR's ability to identify groups of targets? Would identifying one target per group be enough?

Soldier 1: Classified the train as groups of targets.

Soldier 2: Did good job of bringing up everything in the area (and then some). Was impressed with the clarity.

Soldier 3: Yes, there were multiple targets in one array.

Soldiers 4 and 5: Yes one target would be enough. You'll go in live mode to look at it and by nature you'll scan to see what else might be there.

Soldiers 6 and 7: Would want multiple hits for a convoy, but a group of dismounts and/or an RPG team. Using the SA screen (i.e., terrain board), put one icon for a group of enemies/friendlies.

10. How is the layout of the screen displays?

Soldier 1: Screen display- was good. Was too busy learning. When you go live, the whole screen might as well go live. Don't want the extra clutter.

Soldier 2: Want some hot keys like "clear detections", "white hot", etc. on the joystick or on the screen.

Soldier 3: Put the bar scale on the very top, scan mode just below that, and put the mouse input on the lower right.

Soldiers 4 and 5: Good.

Soldiers 6 and 7: It was good, easy to read.

11. How is the sizing of the menu items?

Soldier 1: Sizes are fine.

Soldier 2: Size is fine.

Soldier 3: Adequate.

Soldiers 4 and 5: Fine. If you make them bigger you'd have to take away from something else.

Soldiers 6 and 7: Easy to read, no problems.

12. How is the color coding of the brackets?

Soldier 1: Didn't get the meaning of the chip colors. The hits are what's important, not the color. Correlating the color to the hits isn't important, but the placement of the hits is more important. But colors are good in that they indicate separate hits. The train had hits that were different colors. [A train kept coming into one of the scenarios and the MTI detected each caboose as a separate AiTR hit.]

Soldier 2: Didn't understand the color coding of the chips. Didn't use the color matching as it was designed for. Instead, focused on the azimuth.

Soldier 3: Could see them on the screen. The color coding did help.

Soldiers 4 and 5: Didn't pay attention to it. Noticed it.

Soldiers 6 and 7: Didn't pay attention to them.

13. Is there any information missing from the displays that would increase your effectiveness?

Soldier 1: Haven't played with the system enough to really answer this. Once you laze, would be good to have a grid. You can get a grid but that amounts to time off the screen if it's not automated.

Soldier 2: Grid coordinates would be good- have them come up as soon as you laze a target. Basic info on the SA map or else it gets too busy.

Soldier 3: Don't think so.

Soldiers 4 and 5: Need a 10 digit grid to go with the laser range finder.

Soldiers 6 and 7: Nothing.

14. Are there any alerts or warnings that could help you perform your tasks more effectively?

Soldier 1: If something tells you you've looked at a target previously- a sound would be the quickest. What about a special color- a default color that indicates a previously looked at target.

Soldier 2: No.

Soldier 3: No, just getting used to the system.

Soldiers 4 and 5: New target alerts are too much. If you've located a stationary target and there's a way to pinpoint those and if they become mobile and they would alert you to that.

Soldiers 6 and 7: No noted.

15. Is any critical information easy to overlook?

Soldier 1: No.

Soldier 2: No.

Soldier 3: Bad on switching between modes. Wasn't always aware that he's in live mode.

Soldiers 4 and 5: Polarity.

Soldiers 6 and 7: Clearing detections, setting your elevation, making sure you go back to 1x.

CONTROL QUESTIONS
1. How is the layout of all controls/displays?

Soldier 1: Would want the joystick down by my hip- not above. Make it adjustable to accommodate the left/right hander. How about a lapboard [proposed by Mark Gahler during the interview]? Hate that crap. Placement of screens is fine- need to account for screen size though. Like the sensor screen in front.

Soldier 2: All was good, except would be a problem for a leftie.

Soldier 3: The monitors are good. Placement of screens was OK.

Soldiers 4 and 5:

Soldiers 6 and 7:

2. How easy is it to use the controls overall for manipulating the sensor?

Soldier 1: Overall, easy to use. If you could use a mouse for the joystick functions for some things. [He preferred the GUI controls.]

Soldier 2: No problem, the joystick worked great. Going from live to scan from the joystick would be nice.

Soldier 3: Would prefer not to go from mouse to joystick. Can't perform a mouse click on the joystick. Would want to do all of it via the joystick.

Soldiers 4 and 5: Get rid of the mouse. Will be a pain in the butt out in the field. Stuff gets so dirty out there. A touch screen would be good for moving the WAS, etc. The layout of the joystick buttons are fine. Picked up on how to operate the sensor quickly. It was easy. Want a polarity button on the joystick.

Soldiers 6 and 7: Put black hot/white hot on the joystick. Layout of screens OK. Better to sit than stand. Once you get used to it, it's good. Took one person a while to get familiar with the joystick buttons. Thought they were easy to use. Would have been useful on a gun truck.

3. How easy is it using the joystick in conjunction with other controls?

Soldier 1: Going back and forth- He chose to use certain functions w/joystick and some w/mouse.

Soldier 2: No problems.

Soldier 3: Very *do-able* to have both.

Soldiers 4 and 5: No issues.

Soldiers 6 and 7: No issues.

4. How is the sensitivity of the controls for panning and zooming?

Soldier 1: Fine.

Soldier 2: Seemed pretty accurate.

Soldier 3: No issues.

Soldiers 4 and 5: Liked it, smooth.

Soldiers 6 and 7: Same speed as the game HALO. One guy has to get used to the speed, when got used to it he liked it.

5. How is the ability to adjust sensitivity when needed?

Soldier 1: Never used the "go-fast" button.

Soldier 2: Wasn't a problem.

Soldier 3: Didn't use it. Speed was fine.

Soldiers 4 and 5: No issues.

Soldiers 6 and 7: Sensitivity for the focus could have been better. Didn't use the "go-fast" button- didn't know about it. Didn't feel they needed it.

6. How easy is it to switch your field of view from wide to narrow using the controls?

Soldier 1: Easy to do.

Soldier 2: No issues.

Soldier 3: Easy. Just a few clicks of the mouse.

Soldiers 4 and 5: No issues.

Soldiers 6 and 7: No issues.

7. How easy is it to zoom in and out?

Soldier 1: Fine.

Soldier 2: Fine.

Soldier 3: No issues.

Soldiers 4 and 5: No issues.

Soldiers 6 and 7: No issues.

8. How easy is it to use controls for changing contrast, brightness and polarity?

Soldier 1: Fine.

Soldier 2: No issues.

Soldier 3: No issues.

Soldiers 4 and 5: Brightness/contrast would be good on the joystick. Not hard to adjust polarity, but it's not in a convenient location.

Soldiers 6 and 7: Easy.

9. Is there any aspect of the controls or displays that could cause a Soldier to make any mistakes?

Soldier 1: No.

Soldier 2: When I was in live mode and thought I was in scan mode I didn't notice that the WAS wasn't updating.

Soldier 3: Forgetting to re-set elevation; when you click to go right or left the elevation goes up and/or down and it would be nice to be able to click without messing up the elevation. Forgetting which mode (live or scan) I was in.

Soldiers 4 and 5: No issues.

Soldiers 6 and 7: No issues.

WORKLOAD

1. When do you experience high workloads?

Soldier 1: No workload issues.

Soldier 2: Nothing was high stress.

Soldier 3: When field of view was pretty large (87 degrees, 83 degrees).

Soldiers 4 and 5: No comments.

Soldiers 6 and 7: Constantly scanning back and forth, trying to have eyes on the screen.

2. Why do you think the workload is high in those situations?

Soldier 1: N/A

Soldier 2: Adding salute reports would add to stress. When focused on the screen you tense up. Keeping up with all of your ID'd targets- moving and stationary.

Soldier 3: Lots of area to cover.

Soldiers 4 and 5: No specific comments.

Soldiers 6 and 7: No specific comments.

ADDITIONAL COMMENTS:

Soldier 2: Would be nice to "set" the elevation. Have a "saved" elevation.
Soldier 2: Would be nice to go back to where you were in WAS after you double clicked on an image to go into live scan for a closer look.

Soldier 2: Would be nice to at least have the ability to quickly go from near to far.

Soldiers 6 and 7: Used the SA map for giving grids only. Used the SA map for knowing where he was in a sector.

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