9th International Command and Control Research and Technology Symposium
Information Operations/Information Superiority

Title: **Focused Knowledge to the Warfighter**

Author's:
Name/POC: Dr. Philip J Emmerman
Organization: Army Research Laboratory
Address: Army Research Laboratory
ATTN: AMSRD-ARL-CI (Philip Emmerman)
2800 Powder Mill Road
Adelphi, Md. 20783
Telephone: (301) 3941956
FAX (310) 3945420
E-mail **emmerman@arl.army.mil**

Name: Mr. Randy Woodson
Organization: Army Research Laboratory
Address: Army Research Laboratory
ATTN: AMSRD-ARL-CI (Randy Woodson)
2800 Powder Mill Road
Adelphi, Md. 20783
Telephone: (301) 3941816
FAX (310) 3945420
E-mail **rwoodson@arl.army.mil**

Focused Knowledge to the Warfighter

Philip J. Emmerman, Randy Woodson
U.S. Army Research Laboratory, Adelphi, MD 20783

Abstract

The future dismounted battlespace will require an unprecedented level of automation (software and physical agents) to ensure situational awareness. Soldier directed information management agents, organic autonomous, and semi-autonomous ground and air sensor platforms along with dismounted soldiers must function as a tightly coupled team. These information management functions include operations on global information sources, in particular the fusion of relevant local and global information. Physical agents, such as robotic sensor platforms, will be ubiquitous in the future battlefield, significantly lowering the risks to our warfighters. These physical agents are to complement future manned systems and therefore they must be able to collaborate not only amongst themselves but also with their manned partners. The information from local organic sensor platforms and human assets must be fused to provide enhanced situational understanding. This situational understanding will be further enhanced with the fusion of global information and provided to the dismounted warfighter in a highly intuitive form for rapid assimilation and action. The Army Research Laboratory has recently demonstrated this concept of real time fused information supporting the dismounted infantry. This paper will present the Warrior's Edge information fusion concept, architecture, and demonstration results..

1. Introduction

The United States Army is in the midst of a major transformation. The Future Force must be highly mobile, agile, and lethal to ensure its dominance in the future battlefield. This dominance is reliant on the ability to see and understand first (situational awareness). Persistent and pervasive sensing, coupled with greatly increased speed of information flow, information assimilation, and decisive action, at all levels of our force, are necessary to fulfill this requirement. Dismounted infantry is most vulnerable in urban terrain. This highly constrained, complex environment represents a significant challenge to dismounted infantry. Figure 1 illustrates a future dismounted infantry squad engaged in urban warfare. In order to enhance situational awareness, this squad is augmented by mobile and static sensing assets; unattended ground sensors, small unmanned ground vehicles, a robotic Multifunction Utility/Logistics Equipment Vehicle (MULE), and a small unmanned air vehicle. Each warfighter also acts as a sensor since they are equipped with sensors such as imagers and laser rangefinders. This organic sensor augmentation of dismounted squads is consistent with the Future Combat System (FCS) and Future Force Warrior concepts [1].

Figure 1. Future Urban Warfare Scene

In order to effectively utilize these streams of organic sensory data, it is necessary to fuse it before presentation to the warfighter. These fusion applications remove redundancies, correlate, aggregate, and integrate sensor information with context such as high resolution maps. Current processing power limitations (determined mainly by electrical power availability) obviate the use of a distributed fusion approach integrated within the warfighter's embedded processor (current PDA, wearable, or tablet technology). The Future Combat System concept envisions the squad/platoon level dismounted infantry augmented with a MULE as a logistics carrier to help unburden the infantry from their Herculean load. This vehicle should provide enough electrical power and space for a processing node. This functionality is extended here, by making the MULE an information carrier incorporating an information fusion station. The communications and processing enhancements embedded in a local fusion station also enable linkage to other information nodes. This allows the extension of the network centric warfare [2] approach to the dismounted infantry, effectively linking the future dismounted warfighter (along with organic sensors) and particularly to Global Military Intelligence (assuming security policy will allow). This network coupling of dismounted warfighter (local world) and global Military Intelligence (global world) will significantly improve the situational understanding of both the dismounted infantry and Military Intelligence.

2. Architecture

It is important to note that with the introduction of a local fusion node, the battlefield fusion process becomes somewhat symmetrical. This processing symmetry allows for efficient interaction between the local and global worlds. Relevant global intelligence information can be invaluable to the dismounted warfighter provided it is significant and timely. However, this information must be filtered from the plethora of irrelevant information. These filters must be intelligent enough to select only information that meet a rigorous acceptance criteria based on time, space, mission, certainty, resolution, organization, etc. to minimize information overload or disbelief. Information that does pass these intelligent filters must be transformed to a representation that is readily fused and consistent with the available local information. Figure 2 presents an architecture for this global and local.interaction.

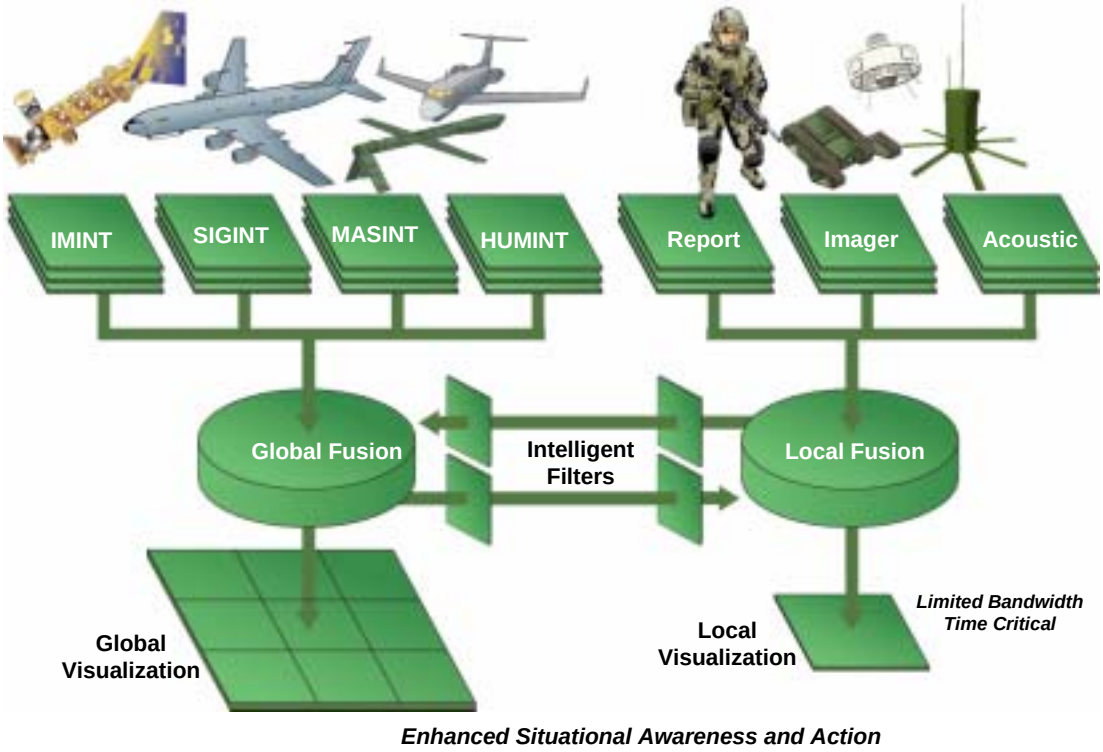

Figure 2. Local/Global Interaction

Similarly information from the local world must be filtered and transformed to be readily ingested and fused in the global space. This local information can impact the global world by providing high resolution ground perspectives, cue global assets, and detect local patterns which initiate global pattern analysis.

A multi-resolution approach to visualization [3,4] as well as analysis is required. A global infrastructure with the ability to visualize the battlefield environment (terrain, weather, entities, features, communications, control measures, etc.) at various resolutions

is needed in both the local and global worlds. This enables the commander to have a custom global view of the battlefield as well as a high-resolution local view to support critical decisions. This same infrastructure supports high fidelity local views for the dismounted commander as well as the ability to jump to other local views to support training or preparation for deployment. This scalability provides a single visualization approach suitable for both global and local applications. A 2D/3D approach is necessary since soldiers are very familiar with two-dimensional maps and can maintain their global situation awareness. However the 2D representation is not as effective for high resolution, complex terrain. 3D representation is excellent for high resolution complex terrain, but it is very easy to lose a global perspective in all the detail presented. Presenting and coupling both views simultaneously eliminates many of the problems inherent in a single view approach. Figure 3 illustrates a coupled 2D/3D visualization approach.

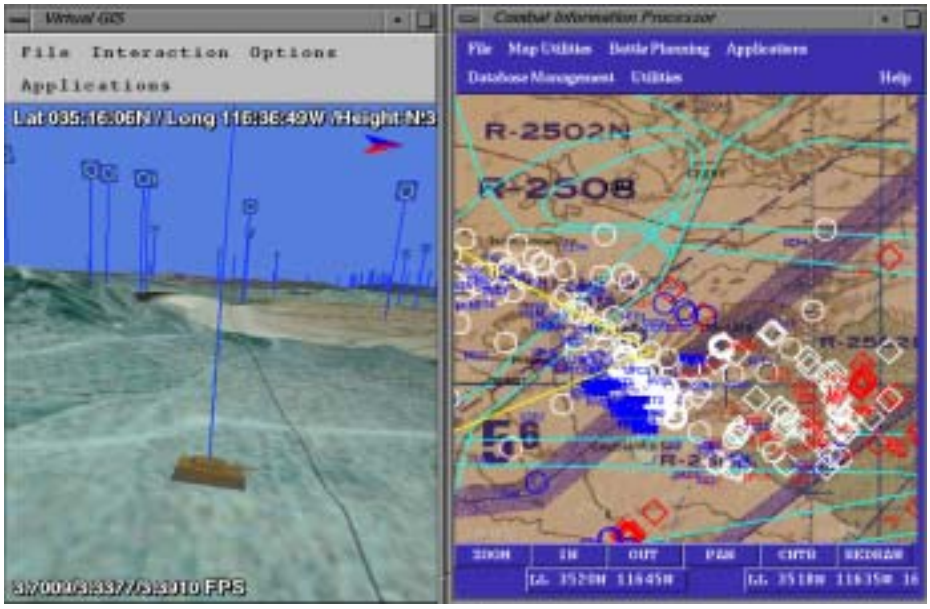

Figure 3. Coupled 2D/3D Visualization

3. Local Fusion

Unlike the well established global fusion domain, the local fusion concept is just evolving. Local sensors included in the initial Warrior ‘s Edge demonstration included acoustic, magnetic, point infrared, visible and infrared imagers, laser rangefinders, ladars, and seismic. The global world can provide information from a myriad and diverse set of sensors {SIGINT, MASINT, IMINT, and HUMINT}. The global world also produces reports from a variety of analysts.
Envisioned local fusion node functionality includes the following.

1. Multiple Hypothesis Trackers
2. Video Mosaicing and differencing
3. Local/Global Fusion {SIGINT, MASINT, IMINT, and HUMINT}.
4. Cross Sensor Cueing

Between Organic Sensors
Between Local/Global Assets

5. Information Kiosk/Visualization
6. Planning/Control for Organic Sensors
7. Pattern Analysis
8. Training
   - After Action Review
   - Simulations
9. Communications Hub
   - Local Node
   - To Global Fusion Node
   - To other Local Nodes
10. Language Translation (text and speech)

This local fusion station is intended to provide a broad range of fusion functionality as well as other useful local information processing tasks. Some examples of these fusion processes will be given. The multi-hypothesis tracker (multi-target, multi-sensor) fusing the acoustic based unattended ground sensor vectors to detect and tract convoys (Figure 4), as well as to localize gunshot and other acoustic events (Figure 5).

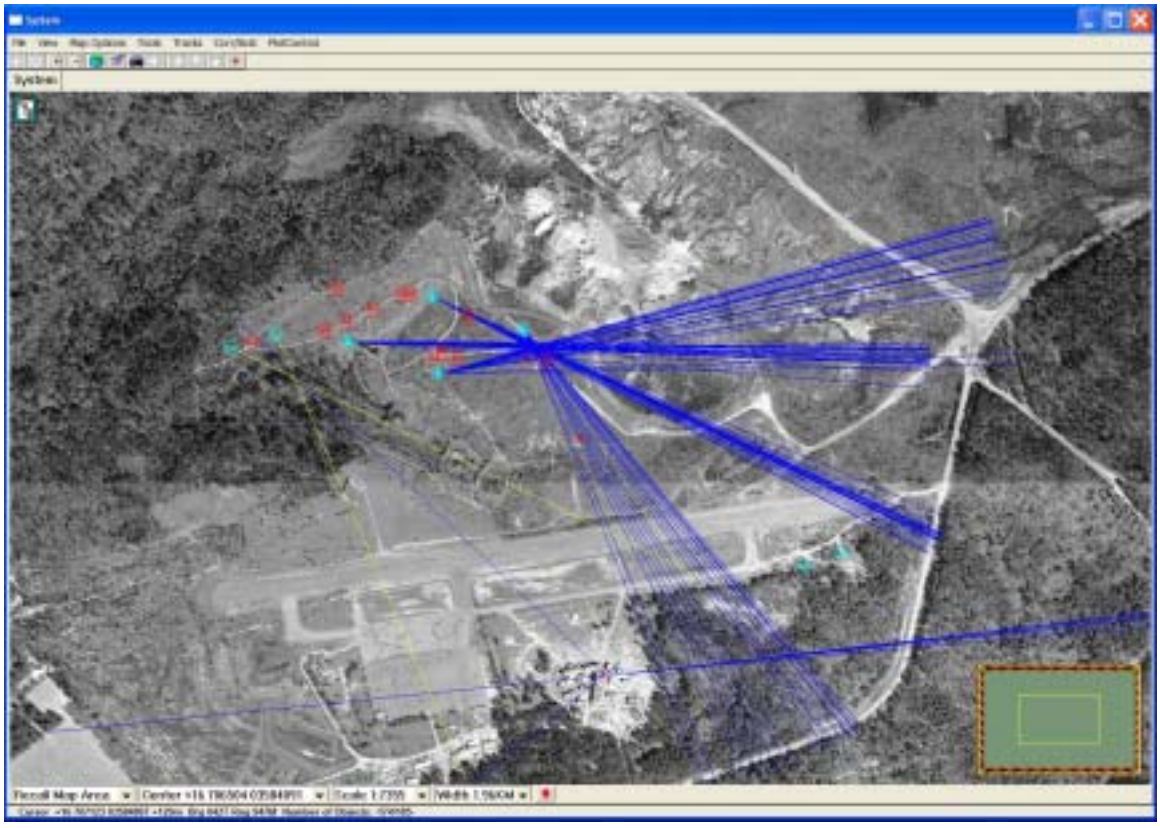

Figure 4. Convoy tracks and lines of bearing

The acoustic and cued imaging sensors for the gunfire detection and localization are mounted on small robotic vehicles. Both the lines of bearing and either the visible or infrared video along those lines of bearing are sent to the MULE for fusion/localization.

Figure 5. Gunshot lines of bearing

Figure 5 shows the line of bearing response to 5 sequential gunshots fired from the corner of a building at the McKenna MOUT site. These lines of bearing are fused to provide a position of the shooter. The cued visible and infrared sensors provide images from those lines to the warfighter. An example of information from global sensors pertinent to the local squad world is high resolution imagery. During the demonstration a high resolution visible image chip was generated and received from the global world and was registered and integrated into the map display (ARCMAP) of the dismounted platoon leader. This image chip passed the spatial and temporal filters. Figure 6 is an image of the platoon leader's display.

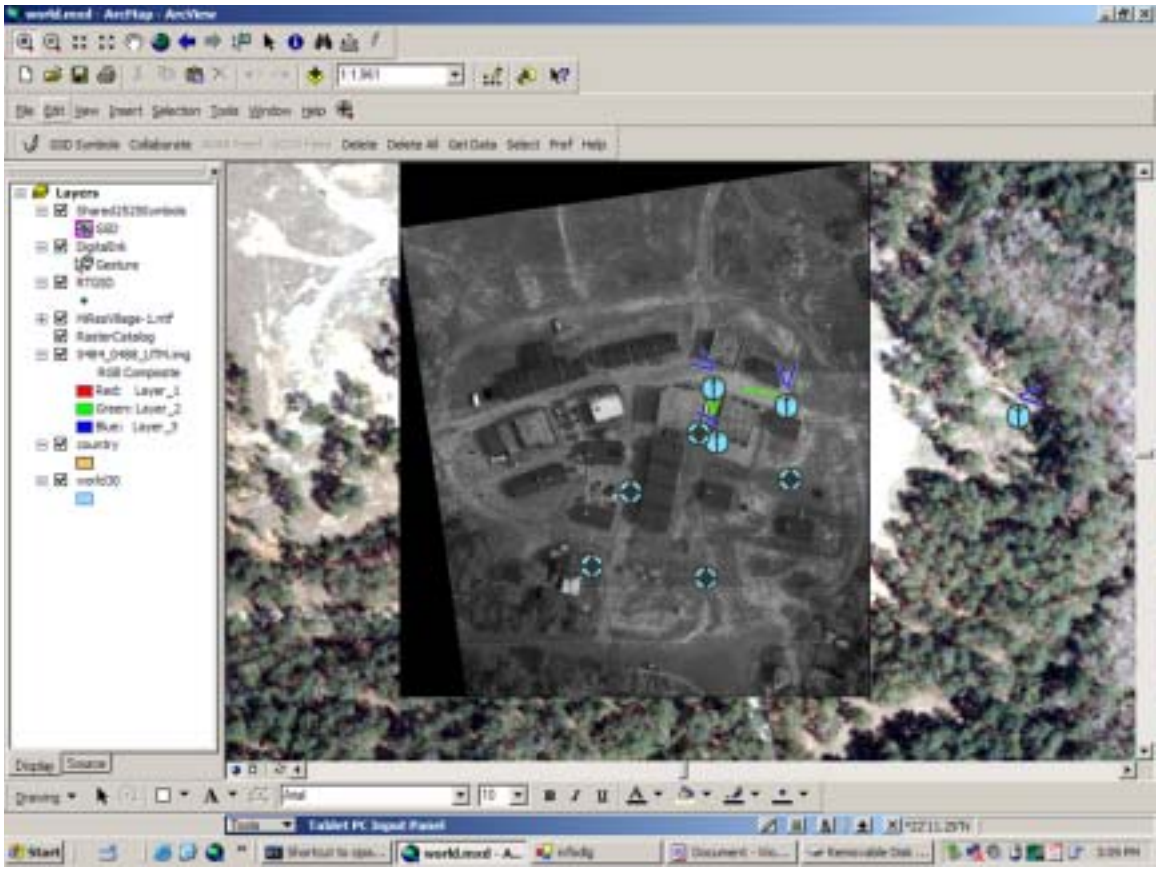

Figure 6. Platoon Leaders display

This tablet display includes the location of the squad members and their robotic assets. The green lines are a use of “digital ink”. The warfighters can graphically communicate and collaborate by drawing symbology and intensions (i.e., they can place standard military symbology on the display and draw freehand, to emphasize areas of interest, movement, or required action).

Conclusion

The Warrior’s Edge program successfully demonstrated the functionality of a dismounted squad local fusion station. This local fusion station provided three critical functions: a coherent integration of the organic sensor information at the local level, the ingestion and fusion of global information that is significant to the squad, and the generation of ground perspective information to the global world. The platoon leader was able to quickly react to this fused sensor information and modify the action of his squad. Situational awareness at both the squad and global levels can be significantly improved with an effective interaction between the local and global worlds. Although not demonstrated in this years exercise, the ability to perform an after action review based on the fusion station’s archived information would significantly improve the warfighters ability to utilize global information. This would be a step toward providing a training environment that links Intelligence and Dismounted Maneuver. Although this effort is focused on the dismounted infantry, all these concepts apply to the mounted domain as well.

References

1. Army Science and Technology Master Plan, 2003
2. Alberts, David S., John J. Garstka, and Frederick P. Stein. " Network Centric Warfare: Developing and Leveraging Information Superiority". 2nd Edition Washington DC: CCRP Publication Series. 1999.
3. Emmerman, P., Movva, U. Intelligent Agent Battlespace Augmentation. Proceedings International Symposium on Methodologies for Intelligent Systems. Oct 2000.
4. Emmerman, P., Walrath J., and Winkler, R. (1998) " Making Complex, Multidimensional Battlefield Information Intuitive" Proceedings of the 21st Army Science Conference, USA.