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Hyper-Enabled Operator: Situational Awareness as Armor

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Abstract: The Hyper-Enabled Operator (HEO) project seeks to increase the survivability of special forces operators through increased situational awareness (SA) capabilities. The precursor to HEO was the Tactical Assault Light Operator Suit (TALOS) which sought to protect operators during room clearing operations by increasing their armor coverage. This study used combat modeling to compare the benefits of HEO to TALOS. This project developed four base models, each based on a relevant mission set. Each base model was compared against two variant models. The first variant provided the operators with enhanced SA. The second variant increased operator armor coverage without a performance degradation from increased weight. For some scenarios the incorporation of SA increased survivability more than a large increase in armor. Further, the study found that enhancing SA increases survivability by 8.3% on average for the four mission sets; this increase is similar to increasing armor coverage by a factor of four.

Keywords: Hyper-Enabled Operator, Situational Awareness, Survivability, Lethality

1. Introduction

Special Operations Command (SOCOM) currently equips its operators with cutting edge body armor to enhance their survivability. This body armor protects the most vital areas on the warfighter, such as the chest and head, leaving 80 percent of the body exposed. Although there is a strong desire to increase this coverage, armor is inherently heavy and bulky since stopping a bullet is a momentum-based problem (Franklyn, 2017). SOCOM evaluated a full-body armored suit concept with the Tactical Assault Light Operator Suit (TALOS) project, where the weight of the armor was carried by an exoskeleton. SOCOM moved away from the TALOS concept and is now evaluating techniques to increase an operator's survivability without adding more armor. One program, the Hyper-Enabled Operator (HEO), seeks to increase an operator's lethality and survivability through increased situational awareness (SA).

Combat modeling offers the ability to quantify the operational changes in soldier performance with the addition of SA technology. This paper uses Infantry Warrior Simulation (IWARS) to quantify the changes in lethality and survivability with the addition of SA technology across a range of SOCOM missions. This paper compares these results to a similar model where the operators are given the benefits of increased armor coverage without the additional weight, similar to the TALOS concept. In doing so, this analysis can equate changes in SA to an increase in body armor and determine if the HEO system can accomplish the TALOS objectives simply through increased SA.

2. Background

2.1 Special Operations Mission Set

Special Operations Forces (SOF) are a subset of warfighters that perform an array of non-conventional mission sets. These mission sets include counterterrorism, foreign internal defense, hostage rescue, high-value targets intelligence operations, and unconventional warfare. Additionally, SOF missions differ from conventional force missions in that they often occur in "denied and politically sensitive environments" (JP 3-05, 2014). In many cases, small units of SOF personnel operate autonomously for extended periods of time.

SOCOM oversees SOF missions for the United States military. SOCOM provides the command and control, planning, resources, and logistics to SOF to enable them to conduct missions. Resources and logistics are handled by Special Operations Forces Acquisition, Technology, and Logistics (SOF AT&L) who ensure that SOF personnel have the necessary equipment to maintain a tactical edge over their adversaries. Since SOF are significantly smaller than conventional forces, SOF AT&L can equip its operators with cutting-edge and highly specialized technology that is not available to conventional forces. In the past years, SOF AT&L has had a major push to provide increased survivability to its operators.

2.2 SOCOM Endeavors to Enhance Survivability

The TALOS project was a SOCOM initiative to enhance an operator's survivability. In particular, TALOS sought to protect the first operator through the door during room clearing operations through 100 percent body coverage with armor. The required armor would exceed 100 lbs., even with novel materials; as such, the suit required an exoskeleton that would offload the weight of the armor (Magnuson, 2015). The TALOS project ran into numerous design challenges related to the immaturity of exoskeleton technology, resulting in SOCOM eventually moving away from the original TALOS concept (Keller, 2019).

The follow up effort, the HEO project, seeks to augment an operator's lethality and survivability through SA technology. It would accomplish this goal by providing capabilities such as better threat recognition, managing operator and enemy locations, reducing cognitive load, and other SA capabilities. The main objective of the HEO system is to provide the right information to the right person at the right time without overloading them. The HEO project is currently in its conceptual phase. It is envisioned as a system of cutting-edge electronics, including sensors, processors, and augmented reality, that can provide SOCOM warfighters a tactical edge (Davidson et al., 2019).

2.3 Situational Awareness

SA is defined as "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future" (Bew et al., 2015). The technology associated with SA provides users with a better understanding of the battlefield through data collection, data processing, and conveying the information to the user. New SA technology includes advanced sensors, big-data processing algorithms, and novel human-machine interfaces.

An example of SA technology currently deployed is the Android Team Awareness Kit (ATAK). This device provides soldiers a view of the area of operation and updated locations of friendly forces and significant events (DHS, 2017). This device attaches to the front chest plate but can be difficult to access during a mission. To provide a more compatible interface, the Army is developing the Integrated Visual Augmentation System (IVAS), which uses an augmented reality headset to convey information to a soldier. It features capabilities such as day and night rapid target acquisition, machine learning, and other data interface features (Siter, 2019). Both the ATAK and IVAS systems only provide data and information relating to friendly forces and positioning. However, with enhancements in sensor and processing technology, these systems will be able to provide real-time information about the location and disposition of enemy forces (Harrison et al., 2019).

3. Methodology

3.1 Process

The overall objective for this study was to determine if the HEO system could meet the goals of the TALOS project of enhancing survivability for an operator without increasing the armor load. Table 1 displays the process used for this study. The study consisted of three phases: stakeholder analysis, problem definition, and solution design and analysis. Stakeholder analysis began with discussions with SOF AT&L to determine the priorities of the project, relevant SA technologies, and mission sets of interest. Using that information, interviews were conducted with previous and current SOF operators to gather information on standard operating procedures, tactical considerations, current technological capabilities, and experience with the mission sets of interest. Simultaneously, market research began into armor and SA technologies and capabilities.

The stakeholder and market research led to the generation of four baseline combat modeling scenarios: key leader engagement, patrol, high value target, and hostage rescue. During the development of these models, lethality and survivability metrics were identified to quantify the addition of SA. Specifically, survivability was measured as the percentage of friendly agents remaining at the completion of the mission and lethality as the percentage of enemy killed in action (KIA). Once finished, the models were delivered to SOF AT&L, who served as subject matter experts to validate the models and metrics.

Solution design and analysis began with the implementation of SA into the models. Each scenario incorporated advanced SA technology that allowed friendly forces to know the location of enemy forces and to readily differentiate them from civilians. Concurrently, this study ran three different variations of the base model with increasing armor coverage—double, triple, and quadruple—with the quadruple armor coverage representing full body coverage similar to the TALOS system. From the output metrics of the SA and armor models, each scenario was analyzed to compare the benefits of additional armor versus the addition of SA technology and equate changes to SA to an equivalent armor increase.

Table 1. The approach used for analyzing the HEO system and comparing it to the TALOS system

Stakeholder Analysis	Problem Definition	Solution Design & Analysis
• Interviews with SOF operators • Discussion with SOF AT&L • Market research	• Baseline models • Identify lethality and survivability metrics	• Modified models with SA • Modified models with armor • Model comparison

3.2 Infantry Warrior Simulation

This study utilized IWARS to determine the implications of adding SA technology to warfighter in an operational setting. IWARS is an agent-based simulation package that analyzes small unit operations for small-scale, ground-based military operations. The primary IWARS simulation objects are intelligent agents that are semi-autonomous, which allows for realistic modeling of soldier and unit behaviors. The methodologies that underly IWARS are stochastic, such that the simulation must be batch run to get a range of output parameters to include measures of lethality and survivability.

An IWARS model is developed by placing friendly forces (represented by blue dots), enemy combatants (red dots), and civilians (green dots) onto a three-dimensional map. Each agent is assigned equipment, movement paths, and behaviors which then allows them to perform a set of tasks that constitute their mission. The behaviors can get very complex and are often based on the actions of other agents in the scenario. The performance of the soldier and their equipment is captured through a parameterized database that can be edited to reflect new capabilities.

4. Scenarios

This section discusses the four combat modeling scenarios, each reflecting a mission set of interest to SOF AT&L. Due to space constraints, only the first scenario is discussed in detail, with the other scenarios only discussed at a high level.

4.1 Scenario 1: Key Leader Engagement

4.1.1 Agent Actions

In this scenario, friendly forces conduct a meeting with village leaders. During the meeting, members of the team pull security around the perimeter of the building. Meanwhile, six enemy combatants are moving throughout the village intermingled with the civilians. The enemy agents are secretly planning an attack on the building hosting the meeting. Once the enemy finishes a reconnaissance of the meeting, they advance to a building in the southwest quadrant of the town. Once all six enemy agents are present, they launch an attack on the key leader meeting. The attack initiates with an enemy agent storming the entrance of the building and detonating a suicide vest as seen in Figure 1 (left). The other enemy agents follow and attack the south side of the building. Enemy forces fire upon both friendly forces and civilians from the cover of another building, and friendly forces move to attack positions to engage the enemy as seen on the right of Figure 1 (right).

4.1.2 Situational Awareness

The key capability modeled in the adapted SA scenario is the use of facial recognition. Friendly forces use a facial recognition capability to distinguish between enemy and civilian agents. When friendly forces realize that enemy forces are congregating and preparing for an attack, they move to battle positions to prepare for an engagement. This model derives its design from a stakeholder who had experience using a digital database to monitor potential threats. Without SA, friendly forces are not aware of the imminent attack resulting in a decreased survivability.

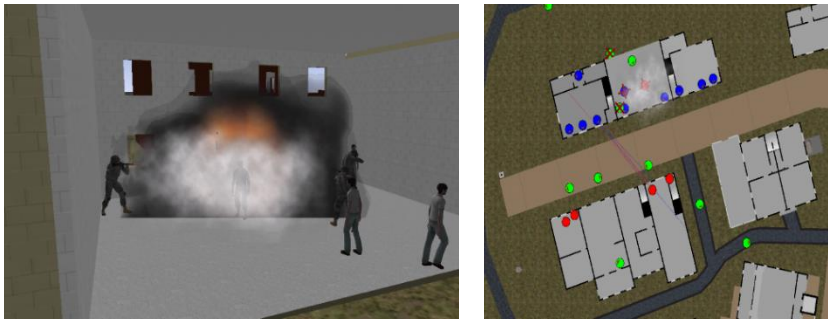

Figure 1. IWARS Screenshots of Scenario 1. (Left) Enemy combatant detonates a suicide vest during a key leader engagement. (Right) Friendly forces take assault positions to repel enemy attack.

4.2 Scenario 2: Patrol

Friendly forces conduct a dismounted patrol through a densely populated area. During the patrol, friendly forces are ambushed by enemy forces, who initiate the attack with a vehicle borne improvised explosive device. The friendly forces are then forced to move down a pathway where the enemy forces have set up an ambush. The friendly forces must then assault through the ambush and break contact. Civilians are present throughout the model and attempt to seek cover after friendly forces take contact, resulting in confusion for the friendly forces who must distinguish between enemies and civilians.

4.3 Scenario 3: High Value Target

Friendly forces conduct a High Value Target (HVT) mission in a multi-story building where there is an enemy team sized element. Friendly forces will clear each floor before reaching the HVT on the third floor and eliminating them. Enemy forces are dispersed throughout the building and take actions against friendly forces. The mission is considered complete when the HVT has been incapacitated. This scenario uses the doorways in the building to canalize the friendly forces, creating several “fatal funnels,” a common problem in urban operations.

4.4 Scenario 4: Hostage Rescue

Friendly forces conduct a hostage rescue in an urban environment where two civilians are in held in a two-story compound. Two friendly teams maneuver and clear through the building, engaging enemy forces that are located inside the compound. There are eight enemy agents inside the building- two of which are located with the hostage. Once the friendly forces clear the first room and alert enemy forces of their presence, the primary objective of one of the friendly teams is to reach the hostages as fast as possible. As one team is moving to the objective, the other will be clearing the path so that the friendly team has cover. The mission is completed once friendly forces safely reach the hostages after clearing the building.

5. Model Results

5.1 Baseline to Situational Awareness

Each scenario was run 80 times for the baseline and enhanced SA case; the results are summarized in Table 2. The lethality score is defined as the percentage of enemy combatants that were incapacitated for that scenario, and the survivability score is defined as the percentage of friendly forces that survived the mission. The lethality and survivability scores increased with the addition of SA by a mean score of 4.8% and 8.25% respectively across all the mission scenarios.

The actual change in lethality and survivability from the addition of SA technology depended on the scenario. Scenario 1 increased by approximately 20% in both metrics, since the facial recognition technology allowed friendly forces to recognize, locate, and engage enemy forces before they could attack the meeting. In scenario 2, lethality did not change significantly as most enemy forces were killed in the baseline model, so the addition of SA was not impactful.

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Table 2. Lethality and survivability mean scores for the baseline model and with enhanced SA

	Baseline (*Std. Dev*)		Enhanced Situational Awareness (*Std. Dev*)	
Scenario	Lethality	Survivability	Lethality	Survivability
Scenario 1	56.2 *(8.5)*	53.0 *(12.8)*	73.1 *(18.2)*	73.8 *(9.3)*
Scenario 2	99.8 *(2.1)*	37.2 *(12.7)*	99.8 (*2.2*)	35.1 *(16.2)*
Scenario 3	90.5 *(10.1)*	64.3 *(13.1)*	96.3 *(8.5)*	75.7 *(7.9)*
Scenario 4	95.5 (*10.2*)	40.2 (*19.7*)	91.9 (*7.4*)	43.8 (*17.1*)

Similarly, there were no significant changes in survivability from the addition of SA. This could be attributed to the enemy forces having a positional advantage in both the baseline and enhanced SA cases. In scenario 3, lethality increased 5.8% and survivability increased 11.4%. Enhanced SA technology allowed friendly forces to acquire targets and kill them quicker, decreasing the time the enemy had to acquire and engage friendly forces. In scenario 4, lethality decreased 3.6% and survivability increased 2.9%, with the standard deviation for both metrics decreasing. The addition of SA was not significant in the model because friendly forces must still clear through all rooms where enemy are located before saving the hostage.

5.2 Armor Equivalency

Each baseline model was simulated 80 times at increasing levels of armor coverage to replicate the TALOS system. These simulations provided the soldiers with increased ballistic protection without increasing their physical load to replicate the load being offset by an exoskeleton. The armor coverage was increased by a factor of 2, 3, and 4 to represent different variants of the TALOS system. The increase in coverage by a factor of 4 would represent the ultimate goal of total body coverage. Table 3 displays the results from these runs. As the amount of armor increased, the survivability index increased; since the soldiers are staying alive longer, their lethality increased as well. However, similar to the SA models, the change in lethality and survivability were highly dependent on the scenario.

The changes in survivability related to both SA and armor were compared to each other. Figure 2 plots the survivability score for the models related to the baseline, enhanced SA, and 4x armor increase. The chart includes the 95% confidence intervals; if the confidence intervals between the variants for a given scenario do not overlap, there is a statistical difference in survivability between the variants. The results indicate that for scenario 1, the key leader engagement scenario, the enhanced SA increased operator survivability more than full body armor coverage. The increase in SA removed the element of surprise for the enemy, allowing the operators to be in a defensive posture and quickly neutralize the enemy. For one of the close quarter engagement scenarios, scenario 3, the enhanced SA effect on survivability is greater than the effect of quadrupling (4x) an operator's armor since they are able to bypass rooms to move to the HVT. However, for scenario 2, since the enhanced SA did not result in a change in lethality or survivability, the increased armor models provided more benefits to the operator. Similarly, the change in survivability for scenario 4 for SA equated to only a 2-3x increase in armor coverage.

These results indicate that for certain scenarios, such as the enemy ambush during the key leader meeting and the HVT mission, the HEO system can provide similar if not better capabilities than the TALOS system could have provided. However, for other mission sets, the increase in SA associated with HEO did not adequately equate to the increase in armor that TALOS sought. As such, SOF AT&L should consider investments in both situational awareness and armor to ensure that all operators can increase their lethality and survivability across a full range of mission sets.

Table 3. Lethality and survivability metrics for increasing levels of armor

	2x Armor (*Std. Dev*)		3x Armor (*Std. Dev*)		4x Armor (*Std. Dev*)	
Scenario	Lethality	Survivability	Lethality	Survivability	Lethality	Survivability
Scenario 1	56.0 *(9.9)*	51.6 *(11.8)*	60.0 *(9.2)*	55.7 (*11.9*)	61.5 *(8.5)*	58.5 *(12.1)*
Scenario 2	100 *(0)*	38.5 *(16.9)*	100 *(0)*	46.0 *(14.7)*	100 *(0)*	50.9 *(16.3)*
Scenario 3	91.0 *(10.0)*	65.5 *(12.6)*	92.5 *(10.3)*	64.0 *(12.1)*	94.3 *(9.0)*	67.1 *(12.1)*
Scenario 4	96.3 (12)	42.1 (18.6)	95.8 (12.3)	44.8 (17.8)	98.2 (7.1)	52.5(18.8)

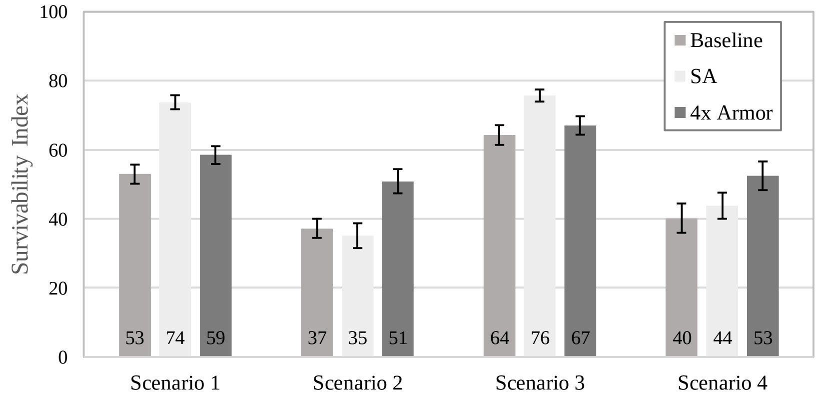

Figure 2. Comparison of survivability between baseline, enhanced SA, and 4x armor coverage

6. Conclusions

The goal of incorporating SA technology for HEO is to increase an operator's survivability and mission success. From the TALOS to the HEO project, SOCOM shifted focus away from equipping operators with more armor towards equipping them with information. The four scenarios developed through this analysis tested the effect of increasing this information through the metrics of lethality and survivability for friendly forces and comparing those changes to increasing armor levels. These models reflected a range of SOF missions and were validated by SOCOM. Two of the scenarios found that SA increased operator lethality and survivability more than quadrupling the armor coverage on the operator, the original goal of TALOS. A third scenario indicated that SA enhanced operator lethality and survivability similar to doubling the armor, while a fourth scenario found that SA did not provide any statistical benefit to the operator. As such, in certain mission sets, the HEO system has the potential to realize the benefits envisioned by TALOS. The results suggest that SOF AT&L should continue efforts to increase SA in tandem with armor development to provide operators with all tools necessary to increase lethality and survivability across a variety of mission sets.

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