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EVALUATION PARAMETERS FOR 360-DEGREE SITUATIONAL AWARENESS SYSTEMS ON MILITARY GROUND VEHICLES

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ABSTRACT

The United States military stands to greatly benefit from perpetual advances in vehicle-borne 360-degree Situational Awareness (SA) systems. However, in recent years, a gap has emerged that hinders development of vehicle-borne 360 SA. At a fundamental level, military ground vehicle designers require unambiguous requirements to build effective 360-degree SA systems; and, critical decision-makers must define requirements that offer substantial operational value. To ensure that 360-degree SA systems effectively address Warfighter requirements, the military ground vehicle research and development communities must better understand vehicle-borne 360 SA evaluation parameters and their relevance to current military operations. This paper will therefore describe a set of evaluation parameters across five broad categories that are vital to effective 360-degree SA: namely, vehicle-mounted visual sensors, data transmission systems, in-vehicle displays, intelligent cuing technologies, and human factors issues. This paper clearly explains the links between these parameters and current military operations; and, it argues that such parameters are critical to uniting stakeholders under a common framework to ensure that 360-degree SA systems provide Warfighters with the means to make sound decisions in combat.

INTRODUCTION

The United States military stands to benefit from steady advances in vehicle-borne 360-degree Situational Awareness (SA) systems. Such systems provide Warfighters with great opportunities to enhance their awareness of a given combat environment to improve both operational effectiveness and Warfighter safety. Therefore, the development and transition of such technologies to Warfighters in the field – particularly those in Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF) – is significant; and, it stands to greatly improve Warfighters' capabilities in combat.

However, in recent years, a gap has emerged that hinders ongoing technical development of vehicle-borne 360 SA. At a fundamental level, military ground vehicle designers require unambiguous requirements to build effective 360-degree SA systems; whereas, important decision-makers must develop requirements that offer substantial operational value. These important communities must therefore connect technical 360 SA specifications and research results to military operational requirements if they are to effectively design such systems for Warfighters in the field.

To ensure that these 360-degree SA systems successfully address Warfighter requirements, the military ground vehicle research and development communities must better understand vehicle-borne 360 SA evaluation parameters and their relevance to current military operations. This paper will describe a set of evaluation parameter across five broad categories that are vital to effective 360-degree SA: namely, vehicle-mounted visual sensors, data transmission systems, in-vehicle displays, intelligent cuing technologies, and human factors issues. This paper restricts its focus to operationally relevant parameters and clearly details the links between them and current military operations.

The U.S. Army RDECOM TARDEC IMOPAT ATO is partnered with the U.S. Army RDECOM CERDEC NVESD, ARL-HRED, and NSRDEC to create effective 360-degree SA solutions on a wide assortment of military ground vehicle platforms. These organizations have developed mechanisms to address the evaluation parameters mentioned above for the GCV, MRAP, and Stryker vehicle platforms, among others. This paper will thereby describe the overall design of the GCV, MRAP, and Stryker 360-degree SA systems and explain their relevance to current military operations. It will identify the links between these solutions and the evaluation parameters mentioned above; and, it will argue that such parameters are critical to uniting stakeholders under a common framework to ensure that 360-degree SA systems provide Warfighters with the means to make sound decisions in combat.

PREVIOUS WORK

The United States military has designed vehicle-borne 360 SA systems on a wide assortment of prototype and fielded ground vehicles. For instance, the U.S. Army RDECOM CERDEC NVESD worked with Industry to develop a 360 (H) x 90 (V) hemispherical vision system for the M2 Bradley in 2008. This system – known as the Distributed Aperture System (DAS) – included color day, image intensified, and uncooled infrared imagers to provide awareness around the vehicle. It contained thirty-three sensors whose images were de-warped, stitched, and fused in real-time and sent to three independent displays. Although Soldiers reported that the DAS increased their SA when compared to the baseline Bradley platform, it also required substantial computational capabilities and would have been cost prohibitive in production. Therefore, future military ground vehicle research and development programs sought to strike a balance between increasing situational awareness while limiting production costs.

The U.S. Army TARDEC Intelligent Ground Systems (IGS) therefore partnered with CERDEC NVESD, ARL-HRED, and NSRDEC to establish the Improved Mobility and Operational Performance through Autonomous Technologies (IMOPAT) Army Technology Objective (ATO). The IMOPAT ATO intends to develop a cost-effective vehicle-borne 360-degree situational awareness and indirect driving system for the new Ground Combat Vehicle (GCV). This ATO aims to provide such capabilities through high-resolution visual sensors and displays, advanced Warfighter-Machine Interfaces (WMIs), automated system control and threat cuing technologies, and occupant workload management systems. By minimizing the number of sensors upon the vehicle and the extent of their support systems, it aims to produce an effective solution at an acceptable per-unit cost to ease transition into the field.

The United States military has also developed several 360-degree SA systems on various ground vehicle platforms that operate in ongoing military operations such as OEF and OIF. These 360 SA systems have performed sufficiently well; but, the vehicles upon which they reside are not typically used during combat but instead for engineering applications. In addition, these 360 SA systems are not extensively produced; and, they are often not well-integrated into the overall vehicle architecture. As a result, the United States military aims to transition 360 SA capabilities onto a wider assortment of combat vehicle platforms – such as the MRAP and Stryker – and to fully integrate them with existing vehicle components and subsystems. These efforts will thereby extend advanced 360-degree SA capabilities to a broad array of ground forces and increase Warfighter combat effectiveness and safety in theatre.

This paper aims to connect these 360 SA development programs and link current operational needs with technical specifications in a generalized manner. Far from being an authoritative discourse on such matters, this paper intends to spur discussions within the military ground vehicle 360 SA development community to build solutions that best meet Warfighter needs.

EVALUATION PARAMETERS FOR 360 SA

Effective vehicle-borne 360 SA solutions for modern combat applications share several vital components, such as vehicle-mounted visual sensors, data transmission systems, in-vehicle displays, automated cuing systems, and Warfighter-Machine Interfaces (WMIs) that effectively attend to human factors considerations. The following section addresses each of these components and defines critical parameters that may be used to evaluate their effectiveness.

Vehicle-Mounted Visual Sensors

Visual sensors are the most fundamental component of any vehicle-mounted 360 SA system. Visual sensors provide the capability to effectively detect, recognize, and identify threats to vehicle occupants from a safe distance; and, they are often augmented by other vehicle-mounted systems that sense the environment through other modalities, such as acoustic waves or lasers. Unfortunately, a single visual sensor cannot address the sometimes-conflicting requirements of a complete 360 SA package alone. For instance, military ground vehicle 360 SA requirements often dictate a threshold resolution for all sensors upon a given vehicle. And yet, these requirements also dictate wide fields of view and long range characteristics. At a fixed resolution, these requirements oppose one another. That is, a sensor with a wide field of view inevitably maintains a shorter range; and, a sensor with a long range inevitably maintains a narrower field of view. These two characteristics may only be improved by increasing the sensor's resolution – which may not be technologically feasible or cost-effective.

As such, military ground vehicles often contain layered 360 SA systems to achieve these conflicting requirements. In the innermost layer, developers often place a set of fixed sensors upon the vehicle to obtain continuous 360-degree horizontal coverage of the surrounding environment. To reduce costs – and thus, the number of components – these sensors typically maintain a wide field of view. As such, they are particularly suited for threat detection – rather than threat interrogation – activities. To achieve this latter capability, engineers develop another layer to the overall 360 SA system that includes high-resolution, narrow field of view sensors upon pan-tilt mounts to interrogate threats from a longer range. Often, these layers are augmented by an outermost layer that provides broad-area SA via video communication with unmanned aerial systems (UASs), unmanned ground vehicles (UGVs), or other military assets.

The primary evaluation parameters that must be considered for vehicle-mounted visual sensors are as follows:

- **Simultaneous Field of View:** This parameter is defined by the field of view that a 360 SA system concurrently obtains across all sensors without interaction from the Warfighter. This parameter characterizes the extent of a given environment that a Warfighter may perceive at any given time.

- **Sensor Field of View:** This parameter denotes the field of view of any given sensor within the 360 SA system. To reduce the sensor count within the innermost layer of the 360 SA system, sensors with wide fields of view are typically used at the expense of range. To account for this deficiency, sensors with narrow fields of view are typically used in the interrogation layer of the 360 SA system.

- **Range Performance:** This evaluation parameter best characterizes the acuity of an imaging system. Range performance is defined as the maximum distance of a target from the imager at which an observer can perform a specified discrimination task using the displayed imagery. For example, the task may be to detect a stationary person in a low clutter environment and fair weather conditions with a probability of at least 70%. The task definition is critical to the range performance parameter; and thus, care must be taken to ensure task definitions are consistent when one compares range requirements. Often, this task definition is unclear or unknown, creating a challenge for system developers.

  An alternative approach has been to use resolving power as a basic characterization of sensor performance. Resolving power, or resolution, is relatively easy to understand and is measured using high contrast bar pattern targets. This is roughly equivalent to a visual acuity test for human vision. However, unlike black and white bar charts, natural scenes consist of a continuous spectrum of luminance levels. Visual performance requires the ability to discriminate small differences in light intensity. This is best described by a contrast threshold function rather than resolution or visual acuity.

  Complex software models calculate the system contrast threshold function to predict the acuity of imaging systems in real-world environments. A standard set of task definitions is required to avoid ambiguous range requirements and to ensure fair comparison between vendors at source selection.

- **Ground Intercept:** The placement of a sensor upon a vehicle platform combined with its vertical field of view is used to establish the nearest intercept of the sensor's cone of vision with the ground. This parameter is often used to evaluate a system's near-vehicle SA. However, a temptation sometimes exists to orient a visual sensor downward to improve the ground intercept parameter. Though sometimes warranted, care must be taken to balance this parameter with visual up-look requirements. For instance, Warfighters within an urban environment may need the capability to detect threats both near the vehicle and from rooftops. Such tradeoffs may only be evaluated after Warfighter operational requirements are clearly defined.

Data Transmission Systems

Data transmission systems aim to transfer information from one component of a 360 SA system to another – for instance, from a vehicle-mounted visual sensor to an in-vehicle display. Modern combat vehicle platforms typically utilize analog data transmission systems for their reliability, ease of integration, and low latency. Under an analog model, visual sensor feeds may be transferred to an in-vehicle display without noticeable delay. However, analog models severely limit the growth of 360 SA technologies because of their limited resolution and their absence of video processing capabilities. The vehicle-mounted 360 SA development community has pressed for the adoption of digital video architectures to provide opportunities to process information through software.

However, digital video architectures present new limitations; in particular, such models typically require greater bandwidth and exhibit higher latency than their analog counterparts. The adoption of such architectures is largely incumbent upon ongoing efforts to increase bandwidth and reduce latency at reasonable costs. Efforts to address these concerns through real-time video compression have typically been unsuccessful because modern hardware compression systems inadequately increase both latency and cost. And yet, digital architectures are clearly needed to provide capabilities to assist Warfighters in modern warfare scenarios. For instance, Warfighters often desire capabilities to discriminate potential threats within an environment through intelligent cuing technologies; or, to identify potential improvised explosive devices (IEDs); or, to record visual sensor data for real-time or post-action analysis; or, to share video information with other battlefield resources. All of these capabilities require digital video architectures to function because they rely upon advanced software-oriented video processing and transmission algorithms.

The key evaluation parameters for data transmission systems are as follows:

- **Bandwidth:** This parameter characterizes the amount of information that can flow between components of a given 360 SA system. Control signals – for instance, to drive a pan-tilt mechanism – typically require very little bandwidth. However, video signals contain much more information; and therefore, bandwidth requirements are typically driven most by video transfer needs. Table 1 provides data rates required to support video signals of various types and resolutions.

- **Latency:** This parameter defines the detector to display delay that the data transmission system supports – that is, from the moment an event is captured by a sensor to the moment it appears on an in-vehicle display. As mentioned, digital video architectures typically exhibit greater latencies because of their inherent overhead and processing requirements. To comfortably operate a 360 SA system on-the-move, Warfighters usually need threshold glass-to-glass latencies below 80 milliseconds. Greater latencies often induce physical symptoms such as nausea and headaches that detract from operational effectiveness.

In-Vehicle Displays

In-vehicle displays typically offer the most natural interface between a Warfighter and a vehicle-mounted 360 SA system. Other interfaces certainly exist – for instance, audible cues or warning lights may also be used to interface with the 360 SA system – but, in-vehicle displays are required to comfortably view and interact with video data from vehicle-mounted visual sensors. In-vehicle displays also provide a means to interface with vehicle diagnostic and management functions; and thus, they are a vital component to any vehicle system. In-vehicle displays typically provide touch interface capabilities that are usually augmented by bezel buttons along their edges. Temptations to develop interfaces through the touch screen capability alone must be tempered because such interfaces invariably require additional physical space within the WMI that may unintentionally obscure important visual information from the Warfighter.

The in-vehicle display is a vital component of the vehicle-mounted 360 SA system; and thus, its parameters cannot be at all disconnected from the structure of the 360 SA system itself. With these considerations in mind, evaluation parameters for in-vehicle displays are as follows:

- **Screen Size:** This parameter constrains the capabilities of the WMI; and as such, it must be sufficiently large to drive an interface that provides desired capabilities but does not obscure important visual information from the Warfighter.

Camera Type	Resolution	Frame Rate	Bits / Sec
LWIR	640x480	30	73,728,000
LWIR	1024x768	30	330,301,440
Color VGA	640x480	30	221,184,000
NTSC (Square)	640x480	30	221,184,000
NTSC (Rect.)	720x480	30	248,832,000
Color XGA	1024x768	30	566,231,040
720p HDTV	1280x720	30	663,552,000
Color Video	1280x960	30	884,736,000
Color SXGA	1280x1024	30	943,718,400
Color UXGA	1600x1200	30	1,382,400,000
1080p24	1920x1080	24	1,194,393,600
1080p HDTV	1920x1080	30	1,492,992,000

Table 1: Data Rates for Various Types of Video Signals

- **Screen Resolution:** This parameter is characterized by the number of pixels within the vertical and horizontal components of the in-vehicle display. This resolution must at least match that of the vehicle-mounted sensors to effectively produce full-screen views; but, it can of course be larger to concurrently display several sensor views and additional WMI information. An inherent consequence of resolution matching is that in-vehicle display and sensor aspect ratios will match, as well.

- **Brightness and Contrast:** These parameters have a major impact on the Warfighter's ability to perceive the displayed imagery and should be considered when determining sensor range performance. Brightness is defined as the maximum luminance of the display; and, contrast is defined as the ratio of brightest to darkest color that the display may produce at any given time. A sufficiently high brightness and contrast display must be chosen to maximize the Warfighter's ability to visualize sensor imagery.

Intelligent Cuing Technologies

Sensors that operate on the vehicle-mounted 360 SA systems described in this paper collect vast amounts of data; and often, Warfighters cannot effectively analyze that information and simultaneously perform other mission-critical operations in a highly dynamic life-threatening combat environment. Thus, significant research and development efforts have focused on techniques to reduce or mitigate cognitive load on Warfighters as they operate a vehicle-mounted 360 SA system. At times, such efforts aim to directly monitor Warfighters for moments of high stress or inattention and thereby reallocate workload requirements to other occupants within the vehicle. The information collected from vehicle-mounted sensors may also be analyzed to cue Warfighters of threats to their own safety. Such intelligent cuing technologies could draw a Warfighter's attention to potential enemy combatants following real-time analyses of visual sensor information; or, they could inform Warfighters of potential IED threats identified by analyses of previously recorded video information; or, they could identify road edges or traversable off-road terrains to mitigate vehicle rollover risks. These cuing technologies could be multi-modal – for instance, by notifying Warfighters of threats with visual, audible, or tactile alerts; and, they may even offer automated response mechanisms to either further interrogate or eliminate potential threats. Therefore, intelligent cuing technologies can be used to increase combat effectiveness, Warfighter safety, and vehicle mobility, among other potential applications.

Unfortunately, intelligent cuing technologies are inherently unreliable because they aim to analyze sensor information in newly encountered environments using statistical methods. These intelligent technologies must often analyze information from noisy sensors within dynamic unstructured environments for which they might not have been designed. Consequently, intelligent cuing technologies often maintain high false alarm rates and low probabilities of correct detection; and therefore, Warfighters often ignore or disable such capabilities through their irritation with a seemingly unreliable system. Therefore, any effort to transition intelligent cuing technologies to fielded vehicle systems must account for critical usability issues.

In addition, intelligent cuing technologies often require high computational capabilities upon the vehicle platform itself; and, the need to analyze information via software algorithms dictates an integrated digital data transmission system, which may not always be available. The computational cost of such algorithms must also be tempered against the overall latency requirements of the 360 SA system as a whole. That is, such algorithms often drive total latencies beyond acceptable limits; and thus, latency constrains the development and transition of intelligent cuing capabilities.

That said, intelligent cuing technologies provide enormous potential benefits for combat operations; and therefore, they must be evaluated against reasonable parameters:

- **Probability of Correct Detection:** This parameter is characterized by an intelligent cuing algorithm's ability to correctly detect the event for which it was designed. Although perfect detection rates in all situations may be unrealistic, the probability of correct detection must not be so low as to render the system ineffective.

- **False Alarm Rate:** False alarms occur when the system misrepresents a non-event as an event for which it was designed. As above, one should never expect a perfect false alarm rate for an intelligent cuing algorithm; but, it cannot be so high as to render the system unreliable. Warfighters often disable intelligent systems that do not reliably identify threats for which they were designed.

- **Computational Load:** Intelligent cuing technologies often require significant computational capabilities; as such, computational load requirements must be defined to minimize the burden on other support systems and to maintain overall latency requirements.

Human Factors Considerations

As described by this technical paper, vehicle-mounted 360 SA systems are incredibly complex; and, the cognitive loads required of Warfighters during the analysis and control of 360 SA subsystems must be reduced through the development of effective Warfighter-Machine Interfaces (WMIs). WMIs are often designed for in-vehicle displays to control and analyze information from vehicle-mounted visual sensors; but, other modalities may be employed to provide primary or redundant capabilities alongside in-vehicle displays. For instance, yolks or keyboards may be utilized to control pan-tilt mechanisms; or, audible messages may be developed to provide redundant threat cuing and localization capabilities. WMIs may be built in various manners; but, they must be developed in accordance with established design patterns that simplify a Warfighter's interaction with the vehicle-mounted 360 SA system. That is, WMIs must above all be simple to provide access to 360 SA capabilities under high-stress combat scenarios.

As a result, WMIs must be developed to account for human factors considerations. By doing so, vehicle-mounted 360 SA developers ensure that Warfighters retain complete access to capabilities within their system – particularly during combat. Human factors considerations are frequently misunderstood by traditional engineers; and as a result, WMI development is often considered to be a near-art form. Fortunately, years of human factors research have brought about the development of standard metrics to assess the effectiveness of WMIs. All of these metrics aim to determine the ease and quickness with which a Warfighter interacts with 360 SA system capabilities. Unfortunately, they must all be verified through extensive user evaluations that are subject to variations in individual tastes and capabilities. Simulations within virtual environments help to reduce the cost of such evaluations; and, they offer useful opportunities to obtain early feedback during the WMI design process.

As such, the following evaluation parameters may be used to assess human factors considerations with WMIs:

- **Probability of Correct Identification:** This parameter represents a Warfighter's capability to correctly identify a target in response to environmental stressors, visual display characteristics, decision aids, and user training modules. This parameter offers the most fundamental mechanism to assess the effectiveness of a total vehicle-mounted 360 SA system.

- **Glance Time:** This parameter is characterized by the time a Warfighter needs to visually sample a scene with the WMI. It is often used to evaluate the effectiveness of interface controls or layouts, in-vehicle displays, and intelligent decision aids.

- **Movement Time:** This evaluation parameter specifies the time that a Warfighter needs to manipulate a control within the WMI. Total movement time may be divided into gross and fine components; and, redundant control modalities may be assessed to establish default control mechanisms.

- **Reaction Time:** This parameter is defined by the time elapsed between the onset of a Warfighter stimulus and his response. As before, several stimuli may be studied to develop the most effective WMIs; but, physiological differences between Warfighters must be controlled in any human factors experiment to prescribe any overall interface design improvements.

VEHICLE-MOUNTED 360 SA SYSTEM DESIGNS

The United States military has developed several prototype and fielded vehicle-mounted 360 SA systems for its combat and military engineering vehicle platforms. They all take into account the evaluation parameters described in this technical paper; but without generalized and unambiguous operational requirements to guide development, each has arrived at slightly different conclusions to inherent questions that permeate the development of effective 360 SA.

In 2009, the TARDEC IMOPAT ATO initiated its efforts to build capabilities to improve closed-hatch vehicle operations, mobility performance, and local-area situational awareness through electro-optic indirect vision, 360-degree SA systems, threat cuing sensors and algorithms, advanced crew stations and WMIs, and cognitive Warfighter workload management and monitoring systems. In essence, the IMOPAT ATO aims to integrate advanced visual sensors onto a surrogate Stryker evaluation platform to provide 360 SA and indirect driving technologies to the vehicle's operators. The ATO eventually aims to transition these capabilities onto the upcoming Ground Combat Vehicle (GCV), Stryker, and MRAP platforms.

The ATO aims to create an affordable hemispherical vision system with a sufficiently wide coverage area, sensible ground intercept and up-look capability, and suitable range response. To do so, the ATO will integrate a continuous 360-degree SA system onto a gigabit Ethernet architecture that supports high-definition (HD) video transmission capabilities. The vehicle platform will have three independently controlled workstations; but, the ATO intends to provide the capability to sustain 360 SA and simultaneously operate other vehicle systems from a single display. The ATO will facilitate this functionality with an advanced touch-screen WMI that takes full advantage of a large in-vehicle display. A diagram of the IMOPAT 360 SA system is presented in Figure 1; and, its WMI is presented in Figure 2.

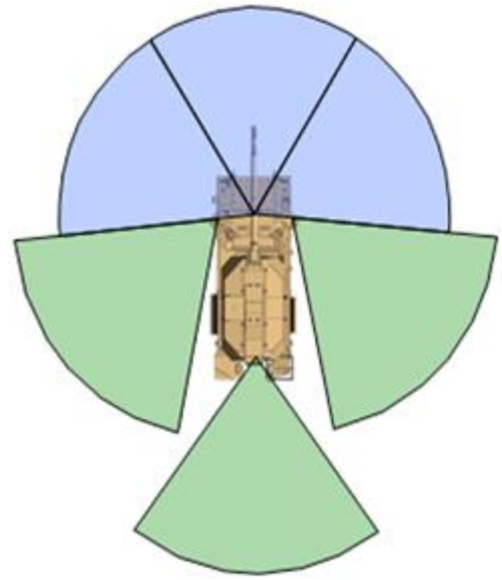

Figure 1: Sensor Placement for IMOPAT 360 SA

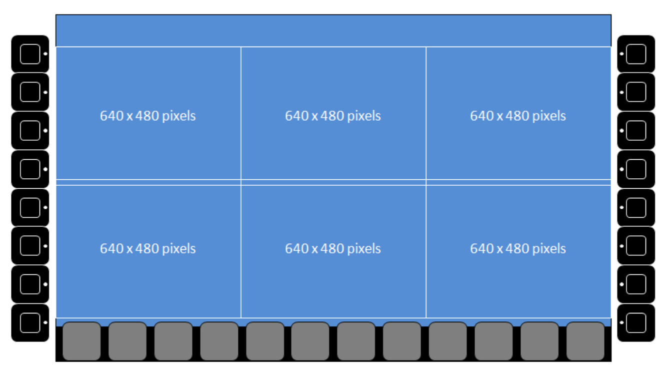

Figure 2: WMI for IMOPAT 360 SA

To assist Warfighters with the detection and localization of immediate threats, the IMOPAT ATO will integrate sensors and algorithms to detect and locate gunfire and accordingly cue the vehicle operator via an integrated display. The ATO will also demonstrate the capability to overlay icons and video clips within the integrated display to provide real-time target cues, user alerts, and vehicle orientation data to Warfighters inside of the vehicle. In addition, the ATO will demonstrate the capability to record video information from the vehicle's sensors onto an integrated database; and, it will demonstrate the ability to tag threats and log imagery within that database for future analysis. Warfighters might use this capability to rehearse missions and identify the locations of IEDs. The ATO will begin to integrate these intelligent cuing and video recording technologies in 2011; and, all of the other capabilities will be fully integrated and demonstrated upon the surrogate Stryker test platform by the end of FY2012.

The MRAP and Stryker 360 SA systems maintain several characteristics that are very similar to the IMOPAT design. But interestingly, these three development efforts were largely independent; and yet, they produced very similar designs and requirements. This is because the vehicle-mounted 360 SA development community now has standard design practices acquired from years of trial and experimentation that are based upon evaluations of parameters described in this paper. The community's ability to design vehicle-mounted 360 SA capabilities has reached a point that mandates increased collaboration between technical and military operational experts. Only by increasing such collaboration may these 360 SA systems continue to provide enhanced operational capabilities to the Warfighter.

CONCLUSION

This technical paper defined a set of evaluation parameters across five broad categories that are critical to effective 360-degree situational awareness (SA): namely, vehicle-mounted visual sensors, data transmission models, in-vehicle displays, intelligent cuing technologies, and human factors issues. This paper also described the general design of the IMOPAT 360 SA system and explained its relevance to the GCV, MRAP, and Stryker vehicle platforms. It did so to unite all interested stakeholders under a common framework to ensure that 360-degree SA systems continue to provide Warfighters with the ability to generate sound decisions in combat. The United States military stands to benefit from such efforts to increase Warfighters' operational effectiveness and safety.

ACRONYMS

ARL-HRED	Army Research Laboratory Human Research and Engineering Directorate
ATO	Army Technology Objective
CERDEC	Communications-Electronics Research, Development, and Engineering Center
DAS	Distributed Aperture System
GCV	Ground Combat Vehicle
IED	Improvised Explosive Device
IMOPAT	Improved Mobility and Operational Performance through Autonomous Technologies
JPO	Joint Program Office
MRAP	Mine Resistant Ambush Protected
NSRDEC	Natick Soldier Research, Development, and Engineering Center
NVESD	Night Vision and Electronic Sensor Directorate
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
RDECOM	Research, Development, and Engineering Command
SA	Situational Awareness
TARDEC	Tank Automotive Research, Development, and Engineering Center
UAV	Unmanned Aerial Vehicle
UGV	Unmanned Ground Vehicle
WMI	Warfighter-Machine Interface

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