DISTRIBUTED APERTURE TECHNOLOGY FOR THE MOUNTED AND DISMOUNTED WARRIOR

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ABSTRACT

Many of the military operations over future decades will be conducted in and around large urban areas. Cities, towns and villages are the political, economic, social, and cultural centers around the world. The control of large urban areas will be critical to the successful accomplishment of strategic, operational, and tactical objectives in future conflicts. Therefore, the Objective Force, as part of it's full spectrum capability, must be capable of engaging in combat against enemy forces that have decided to conduct operations from within and around urban areas.

This paper will discuss Distributed Aperture Technology at Raytheon and will present progress to date on implementation of the DAS functions necessary to realize hemispherical situational awareness for the warrior.

1. INTRODUCTION

Urbanized terrain is a complex and challenging environment. It possesses all of the characteristics of the natural landscape, coupled with manmade construction, resulting in an incredibly complicated and fluid environment that influences the conduct of military operations in unique ways. This manmade construction dramatically increases the complexity of warfare and creates a multitude of friction points that a military force must overcome. Urban areas are not analogous to jungle, desert, or mountain warfare in that there are more than just terrain considerations. The operational and tactical implications of urban warfare (Figure 1) can be characterized as follows:

1. Terrain is characterized by the Urban Canyon (Very Narrow, Low LOS, and Very Steep)
2. Hemispherical, time critical aspect to all decisions and avenues of action.
3. Actions at close ranges (<1KM) and that occur within very rapid time spans (seconds)

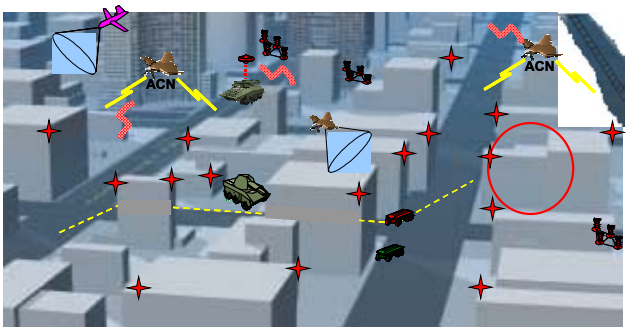

Figure 1 The urban environment for the warrior

These implications will require our future warriors to possess technology that will provide them with superior instantaneous awareness of their surroundings at all levels of engagement.

The United States Army Infantry Center (USAIC) currently has a valid requirement for the capability for soldiers riding inside Infantry Combat Vehicles to be able to see and understand the environment and potential threats around the vehicle before, during and after disembarking to impact responsiveness, agility and survivability (Figure 2). The need for this capability will only be intensified for the Objective Force.

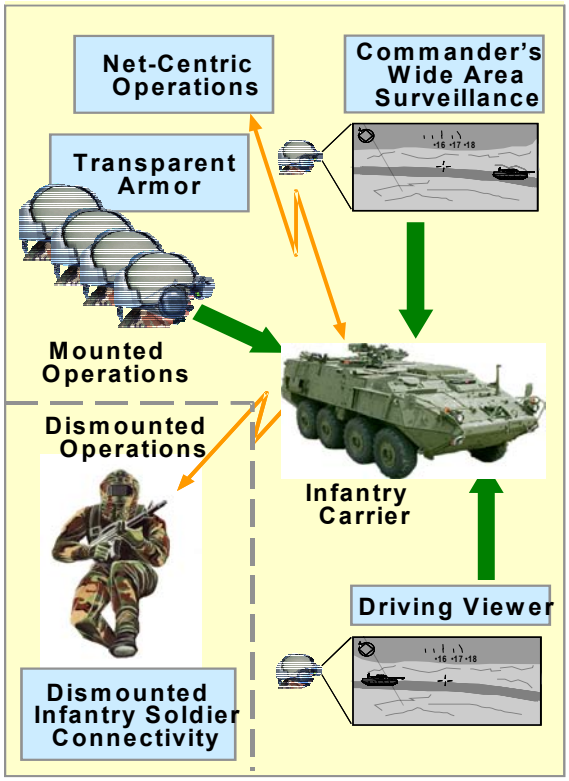

Figure 2 Situational Awareness for the Mounted and Dismounted Operations

For the past 10 years, Raytheon has developed and matured a distributed aperture sensor concept to provide full spherical IR coverage around tactical aircraft. The airborne infrared Distributed Aperture Sensors (DAS) with associated processing can now provide navigation, threat/missile warning, and overall situational awareness functions. With the continuing performance improvements in the long wave infrared uncooled detector technology sponsored by CECOM/NVESD and

DARPA, coupled with the commercially driven advances in processing technology, it is now becoming feasible to demonstrate affordable 360 degree infrared sensor coverage around a tactical vehicle using multiple apertures. Using the DAS approach, data is simultaneously collected around the vehicle without the use of mechanical gimbals. This data can be available to any crew member desiring to look in any direction around the vehicle. The concept also supports the net-centric operations that will be demanded by the Objective Force.

2. APPROACH

The Raytheon distributed aperture system approach is based on a collection of sensors mounted either around a vehicle or co-located in one location where an unobstructed 360 degree line-of-sight can be obtained (Figure 3). All sensors will use the uncooled sensor technology for affordability with each sensor body hard mounted to the vehicle. No sensor gimbals are required for instantaneous, always available 360 degree IR video coverage. Multiple users/functions can make independent use of video data. The sensors are strictly "pixel makers", no processing is done at the sensors. A central processor performs all functional processing using commercial off the shelf (COTS) technology. Standard fiber-channel data buses are used.

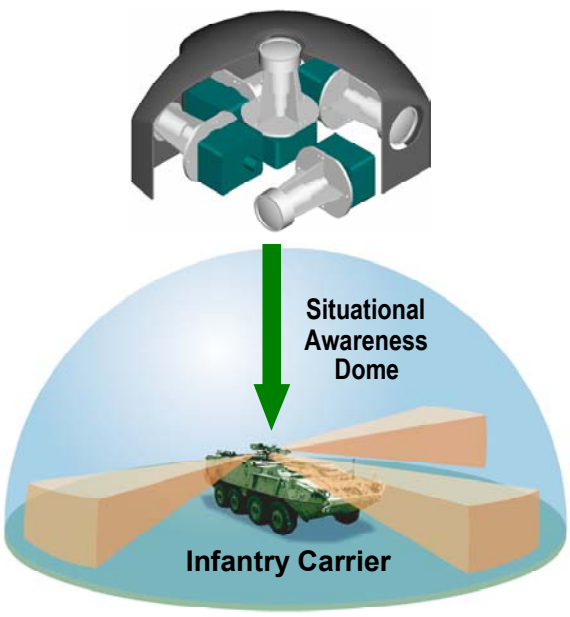

Figure 3 Distributed aperture concept

The key technologies necessary for a viable DAS system for situational awareness and driving are the distortion correction and sensor-to-sensor image blending algorithms. Distortion correction is achieved through pixel mapping. Pixel mapping is accomplished through a series of coordinate transformations and lookup tables, which can account for factors such as optical distortion in the soldier's Helmet Mounted Display (HMD) and DAS sensors. Effectively, each HMD pixel is mapped into a corresponding sensor pixel, from which the HMD pixel intensity can be computed directly or by interpolating between neighboring sensor pixels. Image blending at the seams between sensors must be performed to avoid artifacts, which could distract the soldier. Algorithms that accomplish are being developed, implemented and demonstrated on internally funded programs at Raytheon (Figure 4).

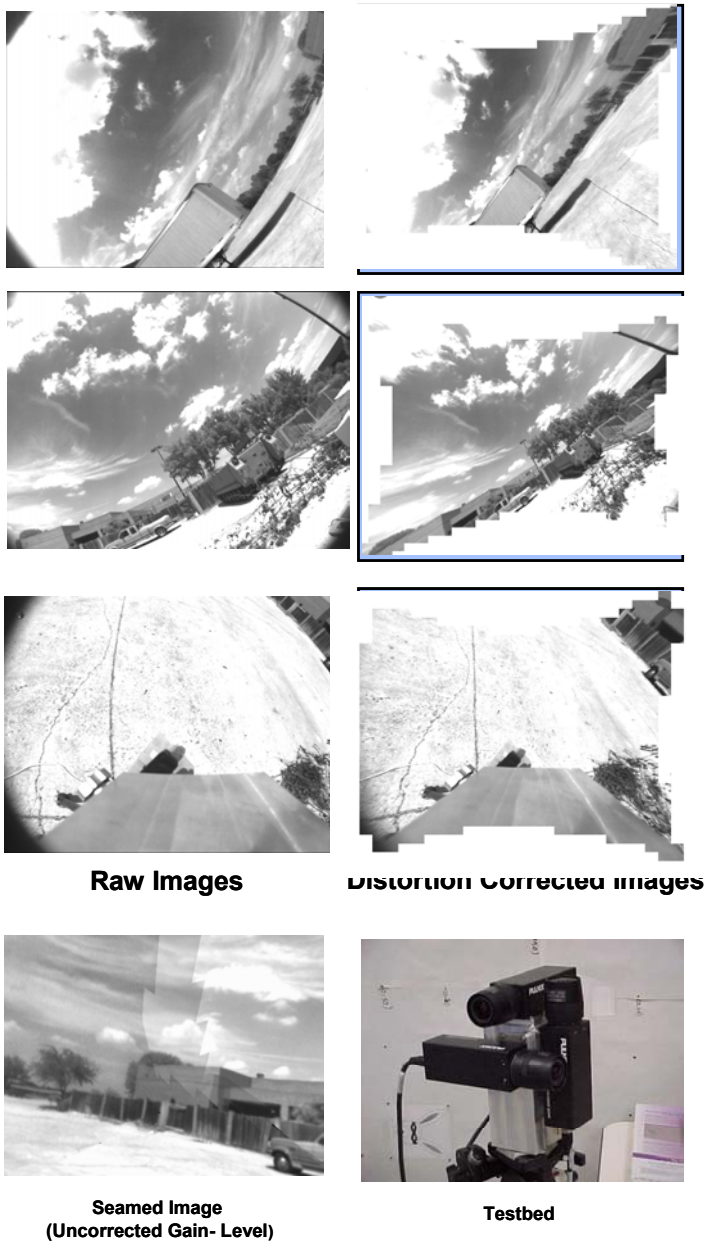

Figure 4 Test bed and resulting seamed image

3. CONCLUSION

Raytheon has made significant progress toward the end goal of providing overall situational awareness to the mounted and dismounted warrior. As the uncooled IR focal plane array and processing technologies continue to develop, the distributed aperture technology will enable this situational awareness for the warrior goal to be met.