OBJECTIVE: Develop a Hostile Fire Detection (HFD) and Active Protection System (APS) cueing and tracking sensor suite. Sensors of interest are stationary, non-imaging, multi-aperture combinations for ground vehicle threats.

DESCRIPTION: US Army effectiveness studies demonstrate HFD systems improve vehicle and crew survivability by creating crew situational awareness and cueing defensive systems. HFD systems can detect both Small Arms Fire (SAF) and larger threats like rocket propelled munitions and missiles. HFD systems with real time resolution can provide Army Fighting Vehicles (AFV’s) detection, classification, and threat tracking.

High-performance sensors effective against both SAF and larger threats are not fielded on ground vehicle platforms due to their high cost, processing overhead, and integration burden. When employed in research and development APS, HFD/APS cueing systems utilize cameras with cooled Focal Plane Array (FPA) technology for weapons flash detection and projectile tracking. While this approach can be effective, the systems tend to be impractical due to high cost and SWaP-C constraints. In addition, high integration and maintenance burdens limit the potential to field this type of technology on combat and tactical vehicles. Radar systems are not passive devices and can be degraded by clutter in the ground vehicle environment. For SAF detection and localization, lower cost acoustic sensors have been employed but are not effective against larger munitions.

Single modality sensor systems have proved to be prone to environmental clutter, noise, and vibration. Users experience high false alarms under typical operating conditions. Methods involving the use of high sample rate (>10KHz), multi-aperture, uncooled IR detectors have shown to be effective in producing accurate detection, classification and angular location capabilities, but can be prone to environmental clutter, noise and vibration. Multi-aperture sensors potentially offer advantages including low cost, low SWaP-C and complexity, very wide instantaneous field of view, low optical distortion, and a minimal solar exclusion angle. Studies integrating such high-sample rate multi-aperture EO systems with an acoustic modality show significantly reduced SAF False Alarm Rates (FAR) even under high noise/clutter conditions. However, introducing movement to sensors increases clutter to a degree that the fusion engine can be overwhelmed and fail to accurately pair events.

This program seeks to produce a low SWaP-C integrated multi-spectral, multi-aperture, multimodal EO, radar, and acoustic sensor product for ground vehicle survivability. It may be used for sense and warn (HFD) as well as cueing/tracking applications (APS), stationary and on-the-move. It must perform with a high probability of detection and negligible false alarm rate under a variety of challenging conditions and operations. It must also be capable of outputting accurate azimuth (bearing), elevation, and range to target, the target classification, and tracking of the target.

The system must be compliant with the MAPS Architecture Framework (MAF).

This topic will address a threat list to include: SAF (e.g. 5.56, 7.62, .50 Caliber), cannons (e.g. turreted, mortar), Rocket Propelled Grenades (RPGs), Recoilless Rifles, and Anti-Tank Guided Missiles (ATGMs).

PHASE I: Investigate and identify materials, packaging, design methodologies and critical design parameters for an HFD/APS cueing and tracking sensor system consisting of a high speed, multi-aperture, multi-spectral sensors for use in on-the-move environments. Analyze and model the far field performance of the proposed sensor where far field is proposed by the contractor and should represent
a militarily useful distance. Build and test breadboards to prove high risk design element feasibility. Begin design of a prototype system that achieves the requirements and capabilities. Deliverables include final report detailing design process, Preliminary Design Review, documentation, and supporting data.

PHASE II: Finalize the initial design from Phase I. Build a proof-of-concept prototype system that will be used for hardware-in-the-loop testing and evaluation. Prototype must be MAF compliant. Perform initial testing and system characterization including testing of the design limits based on the modeling and analysis in Phase I. Identify areas to explore for a finalized system design and technical/programmatic risks. Deliverables include Critical Design Review and documentation, prototype hardware that will be used in government lab and field data collections.

PHASE III DUAL-USE APPLICATIONS: Fabricate and deliver final test article. Support live fire testing, analysis and system upgrades as required. Further mature the technology, preparing for technology insertion into existing programs of record with the transition partner, PdM Vehicle Protection Systems. Deliverables include finalized prototype design documentation, manuals and hardware, including software. A potential commercial application of this project is for autonomous driving vehicles. Mass market autonomous vehicles require multiple, overlapping sensors with many of the same restrictions as military vehicles: clutter, safety, and cost.

REFERENCES:


KEYWORDS: Survivability, ground vehicle survivability, Active Protection System sensors, Hostile Fire Detection, multi-function sensors, multi-spectral sensors