Applying Science and Technology Research to Address Hyperspectral Sensor Test and Evaluation

The Department of Defense (DoD) is currently developing advanced multi- and hyperspectral sensors that span the electromagnetic spectrum from ultraviolet through millimeter wave. These emerging sensor systems represent a significant challenge to the test and evaluation (T&E) community. In Fiscal Year 2002, the Director, Operational Test and Evaluation (DOT&E), in conjunction with the Director, Defense Research and Engineering (DDR&E), established the Test and Evaluation/Science and Technology (T&E/S&T) Program to address S&T challenges affecting the T&E community's ability to test advanced weapon systems. One T&E/S&T focus area is addressing multi- and hyperspectral test.

A synthetic ground vehicle rendered using a Signature Research-developed tool, RenderView, and inserted into a measured scene

Current methods for testing multi- and hyperspectral sensors rely heavily on expensive field test programs. While these field tests provide realistic data for sensor testing, they leave several critical gaps. For example, test conditions are not repeatable. Environments observed one day will be different the next. Imagery can be collected and stored to partially mitigate this deficiency, but this process is expensive and cannot cover the full spectrum of environments required for complete test article evaluation. The T&E community needs the ability to test these advanced sensors in a repeatable, objective fashion before integrating them into warfighting systems. The T&E/S&T Program is addressing these needs through research efforts in scene generation, injection and projection to create test technologies that can be combined into integrated multi- and hyperspectral test capabilities.

One of the key technology developments underway is a next-generation signature model. The T&E/S&T Program is working with Aberdeen Test Center and Signature Research, Incorporated, to develop EOView, a multi- and hyperspectral signature model. EOView is able to merge multiple data sources, including thermal, atmospheric and radiation transport modeling techniques into a single hyperspectral data cube. EOView can estimate signatures at user-specified bands in the ultraviolet through infrared spectral region under a broad spectrum of operational conditions adaptable to the sensor under test. These scenes can be used to stimulate scene projection and direct injection systems or can define how sensors should perform in real-world situations to support T&E efforts.

EOView's physics-based thermal signature model incorporates high-fidelity targets with high-fidelity backgrounds. EOView provides advancement in modeling by leveraging both existing EO models and advanced high-performance computing hardware to create spectral radiometric scenes of unprecedented fidelity. Outputs will be hyperspectral data derived from the hundreds of millions of polygons that describe the target and terrain interactions using physics principles-based energy exchange. One feature of EOView is its ability to thermally integrate high-fidelity spatial targets and backgrounds, including dynamic target interaction with the terrain (plume, dust, smoke, tracks, shadows and so forth). The hyperspectral outputs of EOView can be tailored using the spectral response function of the sensor to create band images. The final version of EOView will be able to generate images across many spectral bands.

Once completed, EOView will be combined with other developments in the T&E/S&T Program to provide the T&E community with the ability to evaluate advanced multi- and hyperspectral sensor systems, under various environmental conditions, in a variety of geographical locations. This capability will be accomplished through generation of high-fidelity and phenomenologically correct images of targets and backgrounds that can be directly tailored to the sensor under test. ❑

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