



NDIA
MDA SBIR Industry Day

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SBIR Discrimination Research Area

Tracy Wentworth



Agenda



- Discrimination Research Area Objectives
- List of Topics
- Topic Overviews
- Questions



Discrimination Research Area Scope and Objectives



- Discrimination Objectives
 - Improve BMDS discrimination, decision architecture and sensor performance capability for the warfighter
- Discrimination Research Area Scope
 - Decision architecture algorithms
 - Weapon and Sensor Resource Management
 - Tracking and Discrimination Algorithms
 - Sensor (IR/RF) Hardware/Software Performance Improvements
- BMDS Relevance
 - Improved decision architecture capability for the warfighter
 - Improved target discrimination performance
 - Improved sensor discrimination performance



Discrimination Research Area

Topic Area	Topic Title	Participating Sponsors	TPOC
Sensor Data Fusion	MDA-07-035 Sensor Data Fusion	DV, GM, AB, BC, TH, MKV	Mark Oliver
Clutter Suppression	MDA07-036 Mitigation of Radar Clutter Using Algorithmic Techniques	DV, GM, SN, AB, TH	Tracy Wentworth
Weapons / Sensor Management	MDA-07 037 Game Theory in Ballistic Missile Defense (BMD)	DV, GM, TH, AB, MKV	Dr. Roger Sullivan
"Sensors"	MDA-07 038 Active and Passive EO/IR Sensors	DV, GM, TH, MKV	Dr. Meimei Tidrow
IR Imagery Usage	MDA-07 040 Forecasting IR Satellite Imagery	DV, SS, BC	James Brown



MDA-07 035

Sensor Data Fusion

Tracy Wentworth



- **Applies innovative discrimination concepts to the fusion of sensor (feature) and contextual scenario information**
 - Develops robust algorithms, software and/or hardware necessary to collect, process and automatically fuse information from multiple sources (radars at same/different frequencies, EO/IR sensor assets) across spectrum of threat classes and environments
 - Seeks to enhance representations of attributes & capabilities of sensor and/or sensor system to facilitate automated sensor fusion / exploitation of sensor data from wide range of sensor systems (radar/EO/IR) and at different data hierarchical levels as required
 - Solutions capable of accurately / reliably supporting acquisition, track, discrimination and engagement of threatening objects across spectrum of threat classes & environments
- **Timeline**
 - **Phase 1: Develop and conduct proof-of principle demonstrations of advanced sensor data fusion concepts/methods for representation of sensor attributes & capabilities that are easily adaptable to wide range of sensors using simulated sensor data**
 - **Phase II:**
 - Update/develop technology based on Phase I results and demonstrate technology in realistic environment using data from multiple sensor asset sources in real-time
 - Demonstrate ability of technology to work in real-time in high clutter environment
 - **Phase III: Integrate technology into BMDS system and demonstrate total capability of updated system.**
- **Enhance BMDS warfighter capability by**
 - Forming single integrated picture of the battlespace
 - Assisting warfighter in making decisions based on evolving battlespace environment
 - Improving optimal discrimination and inference capabilities for threat identification and presentation to warfighter



MDA-07 036

Mitigation of Radar Clutter Using Algorithmic Techniques

Tracy Wentworth



- **Develop concepts & approaches to enhance radar systems ability to perform detection, tracking and discrimination in intentional and / or unintentional cluttered environment**
 - **Proposed approach should allow robust mitigation of one or more types of clutter that is anticipated in a strategic context using any or all of the Missile Defense System's radar capabilities.**
- **Timeline**
 - **Phase I: Develop clutter suppression approach suitable for hosting on one or more MDA radar systems. Develop proof-of-concept prototypes using simulated sensor data**
 - **Phase II: Update , develop and characterize proof-of-concept in realistic environment using data from sensor asset sources in real-time**
 - **Phase III: Integrate technology into BMDS system and demonstrate total capability of updated system.**
- **Benefit is**
 - **enhanced BMDS ability to perform detection, tracking and discrimination in cluttered environment**
 - **enhanced SIAP picture provided to warfighter**
 - **results in improved warfighter decision making ability**



MDA-07 035

Game Theory in Ballistic Missile Defense (BMD)

Dr. Roger Sullivan



- **Applies innovative game theoretical techniques to model weapon and sensor management decisions and strategies to determine the optimum use of assets available through appropriate sensor and weapon resource management**
 - **Develop a framework for modeling an intelligent offense with stressing engagement scenarios against which the defense's weapon and sensor resource management methodologies can be evaluated**
- **Timeline**
 - **Phase 1:**
 - **Develop game theoretical approaches / techniques for computing optimum strategies for offense and defense as a two person game.**
 - **Develop a mathematical model of a BMD engagement capable of demonstrating the effects of change to offense and defense options**
 - **Phase II:**
 - **Update/develop technology based on Phase I results and demonstrate technology in realistic environment using realistic threat scenarios with ability to include incomplete knowledge by each player of others capabilities / pay-off matrices**
 - **Phase III: Integrate technology into BMDS system and demonstrate total capability of updated system**
- **Enhance BMDS warfighter capability by**
 - **Improves single integrated picture of the battlespace**
 - **Assists warfighter in making weapon / sensor management decisions based on evolving battlespace environment**



MDA-07 038

Active and Passive EO/IR Sensors

Dr. Meimei Tidrow



- **Develop active & passive (dual-mode) EO/IR concepts, components and technologies for improved target detection, tracking, and discrimination capability of complex targets at ranges beyond 1000 km for compact & light-weight IR sensors and ladar receivers while considering radiation hardened environment operation requirements**
 - **On-FPA and near FPA data processing and data rate reduction capabilities are also sought for real-time discrimination**
 - **Items of interest include passive IR sensor with higher performance capability vs current state of the art FPA detector technologies, FPAs designed to detect two – four waveband simultaneously, ROIC with sub-nanosecond respond times, hybrid receives simultaneously capable of coherent and direct detection and large format ladar receiver and/or APD arrays operating at 1064 nm**
 - **Performance parameters should exceed those of current state of the art FPA detector technologies**
- **Timeline**
 - **Phase I: Research and develop a conceptual design meeting required physical constraints and parameter requirements and assess expected performance through an extensive system level analysis / modeling effort.**
 - **Phase II: Design, develop and characterize a prototype (at focal plane array level, for example) from the Phase I effort and demonstrate its functionality.**
 - **Phase III: Develop a manufacturing process the sensor system or components developed in Phase II and transitioning this technology to the appropriate BMDS contractor.**
- **Benefit is future passive and active EO/IR sensors for BMD with lower cost, volume, weight and higher performance for acquisition and discrimination capability**



MDA-07 040

Forecasting IR Satellite Imagery for Adaptive Sensor Tasking James Brown



- **Develop advanced algorithms and software to forecasting IR satellite imagery for real-time sensor management and adaptive sensor tasking.**
 - **Develop an innovative capability to forecast satellite imagery of ground terrain based on weather forecast information capable of determining the state of the atmosphere from IR imagery, spatial resolution commensurate with satellite imagery, generating short-range forecasts of up to 72-hours for atmospheric state through dynamical meteorological modeling and producing forecast imagery as seen by IR sensor through radiative transfer modeling**
 - **Consider computational speed, memory requirements for operational implementation along with predictive skill in forecasting satellite imagery**
- **Timeline**
 - **Phase I: Develop an approach for determining atmospheric state from IR imagery and producing 72-hour forecasts of imagery for same location, for any bandpass of an IR sensor. Prototype a robust viable algorithm for forecasting IR imagery and demonstrate the algorithm for a remotely-sensed ground terrain. Assess computational feasibility of implementing algorithm**
 - **Phase II: Evolve Phase I approach into a forecast capability. Demonstrate the potential and feasibility of the software for real world satellite mission scenarios. Assess the predictive skill of the IR imagery forecast capability using well-defined statistical measures.**
 - **Phase III: Integrate technology into BMDS system and demonstrate total capability of updated system**
- **Benefits are an enhanced intelligence mission planning surveillance capability for warfighters**



Questions





Back-ups





MDA 07-041



Threat Objects and Spacecraft EO/IR Signature Predication Code

Capt Steve Mink

- **Develop advanced innovative algorithms and software for determining the image, orientation and surface materials of threat objects and satellites, using tomography reconstruction to support BMDS discrimination and Space Situation Awareness (SSA) & Space Object Identification (SOI)**
 - Effort encompasses both resolved imagery of space objects in low earth orbit (LEO) and unresolved satellites in Geosynchronous Earth Orbit (GEO)
 - Advanced innovative algorithms and software should be capable of computing 3D satellite images using EO/IR reflection tomography and able to extract parameters that describe light reflection from surfaces to sufficient accuracy and specificity for material identification.
 - Computation speed for operational implementation and validation of the rendered satellite imagery must be addressed
- **Timeline**
- **Phase I:**
 - Define issues associated with physics-based light reflection modeling, reflection tomography reconstruction and multi-dimensional parameter optimization of EO/IR signatures of threat objects and satellites.
 - Develop a robust and viable prototype for 3D tomography reconstruction and demonstration using a selected satellite scenario.
 - Assess computational time and potential speed up of software for operational implementation
- **Phase II:**
 - Evolve Phase I prototype into mature software suite for 3D EO/IR reflection tomography reconstruction of threat objects and satellite images with orientation determination and surface material identification.
 - Demonstrate potential / feasibility of software suites for satellite scenarios in real work space environment.
 - Validate image rendering of threat objects & satellite within space environment with respect to standard DoD benchmarks, such as Spectral and In-band radiometric Imaging of Targets and Scenes (SPIRIT) model, for IR spectral region.
- **Phase III: Integrate technology into BMDS system and demonstrate total capability of updated system**
- **Benefits include enhanced threat object discrimination and space object characterization for warfighting decision making**